

THE SUGAR INDUSTRY

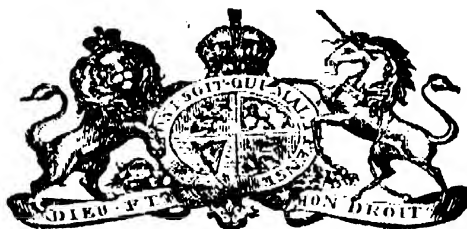
• OF THE,

United Provinces of Agra and Oudh.

BY

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PREFACE.

I HAD been watching with much interest the astonishing rapidity of increase in the import and use of the European beet sugar in the United Provinces of Agra and Oudh since 1895. Successive falls in the market price of the foreign refined sugar led to a gradual, but in the end a very marked, decrease in the price of native sugars, and I soon began to fear that the native sugar-refining industry was certainly to be in most imminent danger within the near future. In the short space of two years the beet sugar replaced the Indian *kānd* and *chini* in the *adwā's* shop to the extent of at least 50 per cent. The druggist prepared his electuaries and the purveyor his jams and preserves largely with beet sugar, and even the poorest opium smoker of Lucknow could afford to indulge in the luxury of sweetening his tea with the brilliant foreign stuff—a pleasure he had never dreamt of before. During my official tours in 1897 in the sugar-producing tracts I made occasional enquiries into the condition of the refining trade, and discovered that the profits had been declining to such a serious extent that in places the sugar refiners were preparing to close their factories.

In March 1898 a strong representation was made to the Government of these Provinces by the Upper India Chamber of Commerce, complaining of the decline in the native sugar trade and urging on Government the necessity of imposing countervailing duties on all bounty-fed sugar that might come into India. This led to a general official enquiry through the Agricultural Department, in which I had to take a considerable share.

While conducting the enquiry above referred to, it occurred to me that, in order to solve any difficulties that might arise in future with regard to the determination of measures for prolonging the life of the native industry in the event of the desired legislation failing to secure that end, it was necessary to have at hand as complete a record as possible of the details of the cultivation of sugarcane and manufacture of sugars. I therefore began collecting the information necessary for the compilation of such a record, and spent the greater part of the cane-crushing and sugar-refining season of 1898-99 in carrying out the enquiry.

I must acknowledge the kindness of successive Directors of this Department which has secured me the time for prosecuting these enquiries.

| | | |
|---------------------------------------|---|--|
| CAWNPORE : The 10th November 1899. | } | S. M. HADI, <i>Asst. Director, Land Records and Agri., U. P. of Agra and Oudh.</i> |
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THE
SUGAR INDUSTRY
OF THE
UNITED PROVINCES OF AGRA AND OUDH.

CHAPTER I.

INTRODUCTORY.

SUGARCANE, *Saccharum officinarum*, is a well-known sacchariferous perennial plant of the grass family belonging to the genus *Saccharum*, and seems to have been known in India from time immemorial. The Sanskrit word for sugarcane is *ikshu*, of which the *Hindi* terms *ikh*, *ukh*, and *unikh* now in use are corruptions.

According to the *Hindu* mythology the plant was originally created by the renowned hermit *Vishva Mitra* to take the place of heavenly sweetmeats in the temporary paradise organized by him for the sake of *Rāja Trishankhu*, whose desire to be translated to heaven was not accomplished owing to a refusal on the part of *Indra*, the monarch of the celestial regions, to admit him before death. A reconciliation between the two *Rājas* having been eventually brought about, the temporary paradise was demolished and all its luxuries destroyed, except a few, including sugarcane, which was thrown down to the land of mortals to afford a permanent memorial of *Vishva Mitra*'s miraculous deeds. Since then the cane is supposed to have been cultivated on the earth. The history of sugarcane cultivation is quite obscure; but we find the plant mentioned in the *Atherva Veda*, one of the oldest and most sacred books of the *Hindus*, from which we quote the following text:—

परित्या प॒रित॒नु ने॒त्रुणा॑गामविद्विषे ।

यथा मा॑क्रामि॒न्यसे॑ यथा म॒न्नाप॑णा असः ॥

“I have surrounded thee with a clinging sugarcane to remove aversion, so that thou shalt not be averse to me.” (*Sacred Books of the East*, Volume 42. Translated by Bloomfield.)

Thus there is little doubt as to the existence of the plant in this country in pre-historic times.

Gar (cane juice boiled to a solid consistency) was also known to the ancient inhabitants of India, as the existence of the term *gar* in the Sanskrit language indicates.

Tradition says that Alexander the Great took a great fancy to sugarcane while in the Panjáb, and carried it with him when returning home, and that it was through this agency that the plant travelled westward.

Among the foreign ancient writers Strabo has alluded to an Indian reed yielding honey, while Dioscorides has actually given the name *saccharum* to a kind of honey obtained from reeds in India. Both he and Pliny describe this product as being white and brittle and of a salt-like consistence. The Greeks and Romans obtained it in small quantities and at great cost from India for medicinal use, and termed it "Indian salt."

The fact that the terms for sugar in the various modern languages are closely allied to the Sanskrit term *sharkarā*, is almost positive evidence of the article being of Indian origin.

The popular notion that the candied sugar, *misri*, was imported originally to India from *Misir* (Egypt) does not appear to be well founded, as the Sanskrit word *misriti* meaning "sweetened" suggests the idea that the art of refining, of which the Arabs are supposed to be the inventors, also originated with the Sanskrit-speaking people. The Arabic term *qand* (loaf sugar) is probably a corruption of the Hindi "*khānd*."

Among Muhammadan writers Ibn-i-Batuta, who travelled in different parts of India towards the close of the 13th century, alludes frequently in his *Safar-nāmah* to the cultivation of sugarcane in various places; but gives no details. He also speaks in eulogistic terms of the magnificent *paundā* cane of the *Malabar Coast*, "the like of which is not found anywhere in India."

The author of the *Makhzan-ul-Adriyya*, who is an authority on medicinal plants, divides Indian sugarcane besides *paundā* into two kinds, (1) the whitish and (2) the red, each having "several sub-varieties." He says the best white canes are found in Bardwān and Murshidabad, also in Panna, Gorakhpur, and Oudh; and the best red canes in Rājmahal, Agra, &c. He gives the following list of the various forms of sugar which were manufactured in India during the Muhammadan period of the Indian history:—

- (1) *Qand-i-siyāh*—The solid product obtained by boiling the cane juice.
- (2) *Shakar-i-ahmar* or *shakar-i-tari*—The product obtained by boiling the juice longer than in the case of (1) and reducing the boiled mass when cooling to a fine powder.
- (3) *Shakar-i-safed*—The sugar obtained by refining the raw materials.
- (4) *Nabāt-i-safed*—The product obtained by refining *shakar-i-safed* with milk or egg albumen.
- (5) *Shakar-i-sulaimāni*—Obtained by subjecting product (4) to a further process of refining.
- (6) *Qand*—Obtained by boiling (5) with water and allowing the syrup to solidify in conical moulds.

- (7) *Ibluj* or *qand-i-mukarrar*—Obtained by reboiling *qand* and cooling the syrup in oblong moulds.
- (8) *Nabât-i-sanjari*—The product obtained by refining *qand-i-mukarrar*.
- (9) *Shikar-i-tabar zad*—Obtained by boiling *qand* with one-tenth its weight of milk till it solidifies.
- (10) *Fâniz* of “drops,” made with boiling syrup prepared by heating product (3) with milk and water, and removing the scum as it rises.
- Some of these products are not manufactured now; others go under different names.

The earliest, and a very valuable, paper treating of the sugarcane of a very important part of these Provinces, *viz.* the Benares Division, was that published by the East India Company in 1793. It is mentioned on page 160 of Volume VI, Part IIA, of the *Dictionary of Economic Products*.

Several other papers of an instructive nature have been written from time to time by different writers since then, but, so far, no attempt seems to have been made to make a fairly complete survey of the sugar industry of the United Provinces. The object of this Manual is to place before the public a brief account of the different forms of cane grown in these Provinces, the methods of their cultivation, and the manufacture of the various forms of the raw and refined sugars.

CHAPTER II.

THE RACES OF SUGARCANE.

A.—Their classification.

THE races of cane grown in the United Provinces may be classified arbitrarily, with reference specially to their agricultural characters and properties, under three broad divisions, *viz.*, (1) *ukh*, (2) *gannâ*, and (3) *paundâ*.

(1) The *ukh* races.—These are the most numerous and most extensively cultivated of all races; they are grown almost entirely for the production of sugar and are little used for chewing, and then only among the lower classes of people. The majority of these races have a fairly hard pith and a hard skin, are small or medium-sized and thin. Their leaves are narrow and small, and the aërial roots are often found only on a few of the lower joints. The internodes are mostly small; many of them have a cavity in the pith when mature, and in some of them the fibro-vascular bundles within the cavity are very prominently developed. The fibro-vascular filaments found within the cavity will, for convenience, be spoken of as the “cavity filaments.” The buds are generally very small and depressed.

In most of them the skin is so firmly attached to the flesh that it cannot be detached with a knife beyond the length of one internode. Compared with other races they require less careful and less expensive cultivation, and they are less susceptible to disease and injurious effects of weather on account of their

hardy nature and are less liable to injury from attacks of wild animals. These races may again be sub-divided into—

- (a) canes with different shades of green and yellow, or—to use the cultivator's term—"white canes"; and
- (b) red canes.

We shall classify the races into certain groups farther on when describing them.

(2) The *ganná* races.—Except in parts of the Meerut, Rohilkhand, Gorakhpur, and Benares Divisions, where these races are grown to some extent for the manufacture of sugar, their cultivation is carried on almost exclusively for chewing purposes, and in the districts in which the cultivation of *paundá* is very limited they are the most favourite races for consumption in this form, being peeled and cut into small bits about an inch long (*gandéji*). They are usually taller and thicker than most of the *ukh* races, and have longer and broader leaves. The skin is generally as hard as that of most of the *ukh* canes, but the pith is always distinctly softer and is characterized by the absence of the inner cavity and the cavity filaments so characteristic in the majority of the *ukhs*. They are generally more juicy, though the juice is not equally rich in sugar. The aerial roots in the *ganná* canes develop more luxuriantly and on a larger number of lower joints than in the *ukh* canes. Their eyes are larger and more prominent, and their skin can be easily detached with a knife to a length of two to two and a half internodes in a single stroke or stretch.

The raw sugars manufactured from them are generally inferior in colour, though rich in crystals. The plants are almost always covered with a thick dark bloom—an indication of the high cultivation which they necessarily demand. They are particularly liable to the fungus disease, "red smut" caused by *Trichosphaeria sacchari*, and are more largely attacked by wild animals, which eat them with much relish, and on this account their cultivation has been gradually diminishing during the past two decades, especially in the Meerut Division and in parts of Rohilkhand, where they are grown mixed with fungus-proof *ukh* canes in the hope of avoiding the absolute failure of a crop.

(3) The *paundá* races.—These races do not seem to be indigenous to these Provinces, some, at any rate, having been imported from other parts of India, and others from foreign countries. They are grown almost entirely for chewing except in Saháranpur and Dehra Dún, where they are to a certain extent crushed for the manufacture of raw sugars, more in the latter than in the former district. Generally speaking, their cultivation is confined to the vicinities of the larger towns. High cultivation, involving heavy expenditure, is an essential feature for the successful growth of a *paundá* crop, and for this reason it is universally believed by the cultivators that in most parts of these Provinces its cultivation for production of sugar would never pay.

The plants are usually tall and very thick, and have a hard skin with a very soft flesh and no internal cavity. The leaves are proportionately long and broad,

and the aerial roots more prominently developed than in the *ganná* canes. In most of them the skin can be separated with a knife to a length extending over two to three joints or more. Proportionately to the size and thickness of these canes, their eyes are generally small.

B.—Division of the various forms of sugarcanes into certain groups, and their description.

It has not been possible, in the course of the investigations in which the materials for the compilation of this work were collected, to carry out a botanical examination of the various cultivated races of sugarcane, and a strictly scientific classification of the races cannot therefore be effected. Dr. George Watt, Reporter on Economic Products to the Government of India, has, after examining the drawings, but not fresh specimens, of the various forms of cane, given certain hints on the basis of which the author has classified the different races into certain groups, the members of each group resembling each other in general appearance and agricultural characters. The scientific accuracy of this classification cannot, however, be guaranteed owing to the circumstances explained. The groups above referred to constitute six series, which are described in the following pages :—

I (a).—Canes other than red.

SERIES I.—The *dhaur* canes.

These are for the most part medium-sized, thin, erect canes of a reedlike form (often furrowed or streaked) and with a firm texture or close-adhering rind not separable as a rule beyond each joint. The joints or nodes, as they are called, are very slightly swollen. The internodes are short or of medium length and only partially constricted. They are at first light lemon green, but turn with age into a pale yellow colour. The leaves are short, narrow, of a firm texture (though they feel soft), and dark green in colour.

Aërial roots arise from the lowermost joints of the stem only, and the stem itself is usually thickest a little above the ground, and from there tapers gradually. The canes of this series, which is represented by Plates Nos. I, II, and III, are enumerated and described below :—

- | | |
|---|---------------------------------|
| (1) <i>Dhaur</i> . | (9) <i>Mangá</i> . |
| (2) <i>Chamli, chamri, or chámray</i> . | (10) <i>Khatuiyá or raihá</i> . |
| (3) <i>Dhumay, kathri, or juláhá</i> . | (11) <i>Ilará or bánsá</i> . |
| (4) <i>Dhauri</i> . | (12) <i>Kínará or katáro</i> . |
| (5) <i>Machná</i> . | (13) <i>Pilá ganná</i> . |
| (6) <i>Sarauti</i> . | (14) <i>Rakhrí or rákhrá</i> . |
| (7) <i>Monichá</i> . | (15) <i>Borí or bódí</i> . |
| (8) <i>Kewáhi</i> . | (16) <i>Arbá or arbi</i> . |

(17) *Karrá*.

(1) *Dhaur*, *dhaur*, or *dhauru*.—The word *dhaur* literally means white, and the cane is so called because of the colour of the bloom, although under special conditions, chiefly high manuring and copious irrigation, the bloom occasionally acquires a dark hue. This is perhaps the most extensively-cultivated cane of the United Provinces of Agra and Oudh, and is held in high esteem, especially in the western districts, being looked upon as the “queen of canes.” The liability of the *agaul* cane, which used to be one of the leading races in the Meerut Division, to the fungus disease called “red smut,” has gradually led to a more extensive cultivation and an increasing popularity of *dhaur*, which has a strong power of resistance against the disease. *Dhaur* is a cane of medium length and thickness, light sea-green in colour, turning into a yellowish green at the age of maturity. It is fairly erect and usually thicker at the bottom than at the top, the thickness in the middle of the cane being fairly uniform. The leaves are broad and of a dark-green colour, fairly soft to the touch, and well spread out from the stem. The thin dry leaves covering the stem are also soft and not very readily removable with the hand or the *hansia*. It thrives best in a rich loam under ordinary treatment, and yields raw sugar of good colour, very rich in crystals, and much valued by refiners.

In damp localities, such as the sub-Himalayan tracts, it gives a fair crop even without irrigation.

In the *bangar* soils of Bijoor this form, though largely cultivated, grows to a small height, the canes being also usually thin. The juice has a bluish tint and a delicious flavour, sometimes with a very slightly acid taste about it, this latter feature having, however, been noticed only in certain localities in the Meerut Division. The epidermis is very thin and easily detached with a knife. In peeling the cane a portion of the pith, which is not hard, usually comes off with the skin. Under normal conditions there is no cavity inside the stem and the “cavity filaments” are also absent, the pith being fairly solid; but when a crop is waterlogged or grown under unusually high cultivation or in the poorest classes of land, the cavity and the filaments form a characteristic feature of the canes. After severe frost red blotches often appear on the skin. The cane at the nodes is fairly brittle and can be broken clean off with the hands at the joints. A feature not uncommonly noticed in *dhaur* is the presence of faint brown streaks on the rind, but this is considered to be a sign of deterioration. Sometimes the stem becomes “sulcate,” i.e. the streaks develop into deep furrows in which the point of a penknife might be inserted without difficulty. This feature is an indication of a particularly rank growth.

The more copiously a cane is streaked or furrowed, the greater deterioration it is considered to have undergone. This tendency to degeneration of *dhaur* has led to the establishment of two inferior forms having characteristic agricultural features. They are (a) *chamli*, *chamar*, or *chamri*, and (b) *dhumar* or *kathri*.

The deterioration is said to be intimately associated with the manner in which the tops are cut for planting. A healthy cutting consists of a small

portion of the top leaves and all the nodes at the top of the canes down to about 15 inches. Should any of the top nodes be cut off with the leaves to be thrown away, the cutting that is then left for planting is considered to be defective and liable to produce a degenerated cane.

If the top has been cut properly, the cane which grows from it will maintain the characteristic feature of *dhaur*; if otherwise, the resulting cane will be a "*chamli*" in the first year. If propagation is made in the next year from the top of a "*chamli*," the resulting cane will undergo further degeneration to become what is known as "*dhumar*." Both *chamli* and *dhumar* are ordinarily thicker and taller than the genuine "*dhaur*," and often their stalks become crooked or bend in one direction unlike *dhaur*, which is straight as a rule. Both are copiously streaked, the *dhumar* more so than the *chamli* or *chamar*. The juice in both cases is distinctly inferior in quality, and so acid to the taste that after chewing a few bits the power of the teeth for gnawing becomes partially paralyzed. Consequently they are not attacked by jackals. The leaf sheaths at the top present a very light shade of magenta, and the same colour is noticed on the surface of the leaves at the stage of germination—a feature as a rule absent in the case of "*dhaur*." Their foliage is more erect than that of the "*dhaur*." The leaves covering the skin are thicker, harder, and a shade lighter in colour.

The "*chamli*" and "*dhumar*" canes yield raw sugars of inferior quality, and are therefore disliked as well for the manufacture of sugar as for chewing. They have both a well-marked inner cavity and "cavity filaments" in them. They do not break clean off at the joints, but split when the force of the hand is applied. They are easily distinguished from each other by the number of streaks and the amount of thickness, which are greater in "*dhumar*" than in the other.

Owing to the impossibility of preparing all the top cuttings in an absolutely normal form, some defective cuttings always find their way into the field at the time of sowing. The presence of a few "*chamli*" and "*dhumar*" canes in the plantations of even the most careful cultivators is attributed to the above circumstance. In neglected crops it is not uncommon to find 20 to 30 per cent. of canes which have so degenerated. Careful cultivators scrupulously avoid taking cuttings from the degenerated "*chamli*" or "*dhumar*" canes should they crop up in a field of "*dhaur*," and in fact every cultivator tries to suppress the progress of "*dhumar*" and "*chamli*" by minimizing the cuttings from degenerated canes in his seed stock. Whether the cause of degeneration pointed out by the cultivators is right or wrong, we are unable to say, but the subject is no doubt one deserving of botanical investigation. *Dhaul* proper is known in Bijnor as "*lamporiâ dhaur*" as distinguished from "*pandariâ dhaur*," which we look upon as a separate race. Another degenerated form of *dhaur* goes in Bijnor by the name of "*gulariâ*," and is recognised from having very small internodes and a short stem, the deterioration being brought about by defective cultivation.

Plate No. I, Figure No. 1, is a typical specimen of *dhaur* proper. Plate No. I, Figure No. 2, is a drawing of a *dhaur* such as is commonly met with in the Meerut district.

A deteriorated form of *dhaur* is known in Moradabad as "*dhauri*," and differs from the typical *dhaur* in being comparatively thin and hard.

Machná.—A dwarf cane of rare occurrence; was found only in the Mainpuri district. One of the main habits of its growth is to throw off shoots from most of its joints. The stem is straw-coloured; aerial roots common at the lower end; eyes small; pith hard and hollow inside; juice very sweet.

The *ráb* manufactured from this cane is of excellent quality, but the outturn is usually very low.

Sarauti (Plate No. I, Figure No. 3).—The name is apparently derived from Sanskrit *srawati*, which means oozing out, and the cane is so called because of the abundance of the juice that it is supposed to contain. It is one of the leading races of the Fyzabad and Gorakhpur Divisions, and also occurs in abundance in parts of the Benares Division, especially the Jaunpúr district.

Sarauti grown in Gorakhpur goes by the name of *dastí*, and is characterized by the presence of a dark bloom over the internodes. In the course of our investigations the best specimens of *sarauti* have been found in Azamgarh. It has a light green colour turning into yellowish green as the cane attains maturity. Red blotches have occasionally been seen on the stem, but this is not the characteristic feature. The cane is thin with no cavity inside. The internodes are usually long with a glaucous bloom over them, and the lower portion of the cane is generally thicker than the top. The eyes are not prominent, and the dry leaves adhering round the stem do not fall off readily from the canes; the aerial roots are but few. It is not quite brittle at the nodes, and breaks only partially when bent between the hands. The pith is somewhat soft; the epidermis is thin, and can be removed easily with a knife.

The *gur* or *ráb* manufactured from this race is very rich in grain, though somewhat reddish in colour. It thrives best on a rich loamy soil, and in tracts where it is grown it is held in great esteem by the cultivators, as may be imagined from the following proverb:—

اوكه سردتي دهولا دهان
يهي چهوڑ جن بويو آن

"Grow *sarauti* cane and *dehulá* rice, and none else."

This proverb is, however, not based on the idea that the *sarauti* cane gives the largest outturn of sugar, which it really does not, but on the fact that it gives very satisfactory results under ordinary inexpensive methods of cultivation and with less care than other canes demand.



Figure 1.
DHAUR
(Sahāranpur specimen)



Figure 2.
DHUMAR
(Meerut specimen)



Figure 3.
SARAUTI
(Jaunpur specimen)



Figure 4.
MOMCHÁ
(Basti specimen)



Figure 5.
KEWAHI
(Jaunpur specimen)



Figure 6.
HARÁ
(Sultánpur specimen)

Momchā (Plate No. II, Figure No. 4).—Is a cane of greenish white colour. It is thin and brittle at the nodes with no cavity inside. The epidermis is hard and covered with dark bloom. The dry leaves remain firmly attached to the stem. The eyes are prominent and the upper part of the cane is thicker than the lower. The stem is not erect and usually bends before growth is complete.

Kewāhi (Plate No. II, Figure No. 5).—One of the important races of Benāres, Jaunpur, and Mirzapur, somewhat similar to the *sarauti* and in parts of Allahabad looked upon as identical with it. When full grown the cane is of a yellowish green colour with irregular pink or reddish brown stripes or blotches on the nodes, which are often thickly covered with a dark bloom. The skin is hard, thick, and flexible, and the pith soft with practically no hollow inside except the lower joints, in which the cavity filaments are well marked. The stem does not break clean off at the nodes, but splits in breaking. The stem is flattened as in the case of *hārā*, and the internodes are long. The dry leaves are very thin, but firmly attached to the stem. The eyes are large and aerial roots few. It is a hardy cane and flourishes even on comparatively poor soils under less generous treatment than the *mangā*, being also less sensible of injury from waterlogging.

The raw sugar made from it is rather reddish in colour, though rich in grain.

Mangā—also called *mayāpurī*.—Colour green with red blotches on the stem, pith soft; the juice has a little acidity in it.

Khatuiyā or *raihā*.—Is a green cane of Rohilkhand akin to *dhaur*. Its internodes are, generally speaking, shorter than those of *pandariā* and longer than those of *dhaur*.

The epidermis is very thin and cannot be detached easily with a knife. A dark bloom covers the internodes. The colour of the skin at the nodes has a deeper tinge of yellow than in *dhaur*, and the foliage is a shade darker green and more branching than that of *dhaur* and *pandariā*. The pith is somewhat soft as compared with *dhaur*, but the juice is less rich in sugar (*sucrose*) than that of either *dhaur* or *pandariā* and distinctly acid; hence the name. The *rāb* manufactured from *khatuiyā* is tinted green. Its *gur* and juice have also a deeper shade of green than those of *dhaur* and *pandariā*. It stands waterlogging more effectually than *dhaur*. It is scarcely sown by itself, being almost always mixed with *dhaur* and *pandariā*.

Hārā, *hārā*, or *bānsā* (Plate No. II, Figure No. 6).—As its name signifies, is a cane of generally hard texture. It is a small-sized cane with a thin stem, often very close-jointed towards the top. The skin is not easily separable with a knife, but comes off in bits. The pith in the greater part of the stem is solid, except in canes grown under poor cultivation. A few of the lower nodes

are, however, hollow as a rule with well-developed "cavity filaments" varying from 3 to 15 in number, which can be easily counted. The colour of the skin varies from a light sea-green to a dull pale green, the lower internodes being sometimes of a light canary or straw colour. The bloom is white or at the joints slightly dark grey. On some of the internodes very small brown specks or blotches may occasionally be seen. It can well stand the effects of stagnant water, and on account of its hard character is not liable to much damage by wild animals or insects. The stem, instead of being round or circular, is perceptibly flattened from top to the base, so that a cross section of it is oval. This is the main distinguishing feature of the cane. Aërial roots are absent except about the lowest joints. The leaves are perfectly erect and thin. The buds are small, except on a few joints at the top, where new shoots begin to sprout when the canes attain maturity.

The *gur* or *râb* manufactured from it is of a reddish colour, but rich in grain.

Kinârá (Plate No. III, Figure No. 7).—A comparatively soft race of *ukh* generally grown in conjunction with *dhaur*. The colour of the skin is green, turning into a yellowish green towards the latter period of growth. The bloom is conspicuously absent, and the cane has reddish rings at the joints. The juice is nearly as agreeable to the palate as that of the *paundâ*. Its skin is transparent and smooth, and can be detached to a length of three to four internodes with a knife. A typical *kinâr* cane is copiously covered with reddish brown streaks. It splits when broken at the joints. The leaves are erect and long. The sugar it produces is reddish, but very rich in crystals. *Kinârá* is known in Rohilkhand as *katâro*, which should not be confounded with *katârá*. *Kinâri*, as its name implies, is an allied form, differing from the *kinârá* in being comparatively thin, short, and scantily streaked and in having a richer and more delicious juice. It is stated that *kinârá* is liable to degenerate occasionally, and when this happens the streaks on the internodes become few and faint, and the juice yields a poor quality of sugar.

Pilâ gannâ.—A straight cane, having a fairly thick stem of pale yellow colour (hence the name *pilâ*) with streaks on the internodes; eyes prominent; bloom dark; epidermis smooth, thick, and easily detachable; cavity filaments well developed. The juice has a slightly acid taste; aërial roots present on several joints in the lower parts. Produces *gur* or *râb* of a rich quality. Its cultivation is confined to the tahsíl of Baheri in the Bareilly district.

Rakhri (Plate No. III, Figure No. 8).—This is one of the important canes of Rohilkhand, seldom grown singly, and very frequently in conjunction with "*dhaur*" and "*chan*"; thrives best in *dumat* soil and yields juice fairly rich in sugar. The colour of the skin is greenish yellow turning into a pale yellow when



Figure 7.
KINAR
(Meerut specimen)



Figure 8.
RAKHRI
(Shahjahanpur specimen)



Figure 9.
BODI
(Muzaffarnagar specimen)

the cane attains maturity. The internodes are copiously streaked and smaller than those of the *dhaur*; the aerial roots extending to a greater height in the lower part of the cane. The stem is not brittle at the joints, and the epidermis can be easily removed with a knife to a length of two internodes. It is less juicy than the "*pandaria*." It resists the effect of waterlogging, and is therefore specially adapted for cultivation in low lands.

Bodi or *bori* (Plate No. III, Figure No. 9)—Is an erect cane of medium size, largely grown in the Rohilkhand and Meerut Divisions in conjunction with *dhaur*, *kindra*, and *sarethá*. The stem is yellowish green, having a red ring at the nodes, and is generally scored and streaked. The eyes are prominent, internodes short and hollow, and the cavity filaments well-developed. The joints are covered with a glaucous bloom. The dry leaves remain folded tight, and the skin is thick and tough. The pith is soft and the juice abundant and sweet. The aerial roots are common at the lower end. *Bodi* is one of the valuable sugar-yielding canes.

Arbá.—*Bori*, like *dhaur*, is liable to degenerate as *arba*, *arbi*, or *arri*. The deterioration is said to be due partly to careless cultivation and partly to the defective manner in which tops are cut for planting, as already stated under *dhaur*. The degeneration usually begins at the top in the first year, in which only the upper half of the cane changes its features, the lower half maintaining the characters of the original cane. In the course of two or three years the degeneration is complete, and the cane acquires the characteristic appearance of *arbi*.

Arbá is a thin cane with long internodes. The aerial roots are luxuriantly developed. The stem is tough and the "cavity filaments" well marked, eyes prominent, and juice sweet.

Karrá—Is one of the Bundelkhand canes grown only to a limited extent. When in perfection the colour of the epidermis is straw coloured and spotted with red blotches. The pith is hard, the juice scanty, sweet with some acidity in it, and poor in sugar. The internodes are short and the leaves long and narrow.

SERIES II.—The *matná* canes.

These are short, thin, yellowish green in colour, and brittle at the joints. The stem is marked with pink or red spots or stripes, and the skin adheres firmly to the pith. The series is represented by Plate No. IV, and the following is a list and description of the various forms belonging to this group:—

- | | |
|---------------------|---|
| (1) <i>Matná.</i> | (6) <i>Khajrá.</i> |
| (2) <i>Agauri.</i> | (7) <i>Pandaria dhaur</i> or <i>pandrá.</i> |
| (3) <i>Bápsi.</i> | (8) <i>Subá.</i> |
| (4) <i>Bhar.</i> | (9) <i>Bhadrá.</i> |
| (5) <i>Kághazi.</i> | (10) <i>Arkará.</i> |

Matná (Plate No. IV, Figure No. 10) — Is one of the most esteemed races, grown chiefly in the loamy soils of eastern parts of the Doáb and Rohilkhand and in the north-west of Oudh. It is supposed to have been imported originally from Malwa.

Generally speaking, it is one of the short and thin canes, but under specially high cultivation it has been found to grow tall and fairly thick. Under such circumstances it is, however, apt to fall over and throw off shoots from the joints. It yields a large outturn of raw sugar of excellent quality, and is considered in Hardoi to be superior even to *dhaur* in that respect. The stem is yellowish green, which turns into a straw colour at the time of maturity, and is brittle at the joints.

A feature invariably present in Hardoi and Sháhjahánpur is the appearance at the end of the rains of reddish brown spots or patches round the stem just above the eyes, which are small and depressed. When grown with proper care on uplands the pith is solid; but under opposite conditions, or when the stems fall over, the cane becomes hollow inside, and is marked with the presence of the "cavity filaments."

The rind, which is thin, is very firmly attached to the pith, and comes off in small bits if an attempt be made to peel it with a knife. The pith is fairly soft for an *akh* race. The aerial roots are few except in fields which have been waterlogged. The leaves are erect and broad, and the stalk thinner at the top than at the base. The juice, especially from the upper half of the cane, is slightly acid.

It is stated with confidence that this race maintains its character only if cuttings from the whole cane be employed for planting. By sowing the tops alone the cane degenerates into the inferior form known as *agauli*.

Agauri or *agauli*.—This is one of the inferior canes of the Sháhjahánpur district, alleged to have been established from degeneration of the *matná*. It is stated that the deterioration takes place by planting the tops of the *matná*, the resulting canes acquiring the characters of the *agauli*. The term *agauli* literally signifies a cane propagated from the tops.

On account of its inferior qualities it is never grown by itself; always in mixture with *dhaur*, *dikchan*, and *chan*. The colour of the stem is yellowish green with small reddish patches in parts. The rind is thin, but hard and firmly attached to the pith, and the eyes prominent. The stem is always hollow, with the characteristic filaments well developed inside. The juice has always more acidity about it than that of the *matná*.

Agauri, whether propagated from the tops or from the cuttings of a whole cane, maintains the features peculiar to it, and never recovers the characters of the parent *matná*.

Bánsi (Plate No. IV, Figure No. 12) — Is a thin cane with a delicious juice. The colour of the epidermis is greenish yellow, spotted with deep pink blotches.



Figure 10.
MATNA
(Kheri specimen)



Figure 11.
KAGHAZI
(Pilibhit specimen)



Figure 12.
BANSI
(Hamirpur specimen)

The stem is very tough. The pith is soft and juicy, and the skin thin and hard; leaves erect.

Bhar.—A thin, straw-coloured cane; pith hard; juice sweet; eyes small and prominent; leaves erect.

Kāghazi (Plate No. IV, Figure No. 11).—A medium-sized, straw-coloured cane. Buds small with a flattened stem like that of the *hārā*, and is so called because of the thin and smooth “paper-like” skin, easily separable from the pith. Pith fairly soft with no cavity inside. Some of the internodes streaked and spotted reddish brown; juice very sweet. Grown to a small extent in the districts of Bareilly and Pilibhit.

Khajrā.—A yellowish green cane with short internodes, some of them streaked as in *vakhri* and spotted in parts with blood-red or brown blotches; eyes very small, aerial roots appear on the lower six or seven joints; skin easily detachable with a knife; juice rich and sweet.

Pandarā-dhaut, *pandarā*, or *panparā*.—This is largely cultivated in the north of Rohilkhand and of Oudh. It resembles *dhaur* proper only in colour of the skin and of the bloom, and differs from it so materially in other respects that it will, we believe, be a mistake to reckon it as a form of *dhaur*, as cultivators in some parts of Rohilkhand seem to do. The cane is generally longer and thicker than the *dhaur*, the thickness in the middle and towards the top being greater than at the base. The stem is remarkably flexible and has a zigzag form from joint to joint and a marked depression near the eye at each node.

The epidermis and the pith are harder and the top leaves more erect as compared with *dhaur*, and the cane, on account of its hardier nature, resists the effects of waterlogging more effectually. The internodes are comparatively small and occasionally streaked, but are not so brittle at the joints as in the *dhaur*.

It yields sugar of fairly average quality and may, on the whole, be regarded as a valuable variety.

Sabiā.—Is a green cane with a hard rind and solid pith, poor in juice, which is, however, very sweet; grown to a very limited extent in the Fatehpur district. Further particulars are not known.

Bhadwā.—A thin, erect cane; colour yellowish green; internodes spotted with catechu brown blotches; cavity filaments fully developed; aerial roots common at the lower end; eyes prominent; leaves perfectly erect.

Aykarā.—One of the rare forms of Doāb canes; has juice rich in sugar and sweet; pith hard; leaves short.

SERIES III.—The *kuswár* canes.

These may be viewed as closely related to the first group, but are altogether thicker, stronger, and more erect and brittle. They have a pale swelling above the actual joint or node, and with the internode distinctly contracted towards the middle. Many of these canes become striped longitudinally or have roseate patches on the otherwise yellow or pale greenish texture, and the bloom, especially near the joints, frequently turns dark coloured. They yield a juice rich in crystalline sugar, and are highly prized on that account by the owners of refineries. Plates Nos. V to VII represent the series, and the members constituting it are named and described below :—

- | | |
|-------------------------|---------------------------|
| (1) <i>Kuswár.</i> | (7) <i>Hemjá.</i> |
| (2) <i>Mango.</i> | (8) <i>Tesarwá.</i> |
| (3) <i>Motki mango.</i> | (9) <i>Patarki mángo.</i> |
| (4) <i>Bhardngá.</i> | (10) <i>Reori.</i> |
| (5) <i>Reora.</i> | (11) <i>Charkahá.</i> |
| (6) <i>Dhaura.</i> | (12) <i>Karwá.</i> |

Kuswár, *kusiár*, *khusiyáliyá* or *khushali* (Plate No. V, Figure No. 13).—The term *kuswár* is apparently a corruption of the Hindi word *sukwár* (delicate), and the cane is so called because of its brittle nature ; a single jerk with the hand being sufficient to pull the cane out of the ground. *Kuswár* is a cane of highly esteemed description, most commonly grown in Sultánpur, Partábgarh, and parts of Allahabad. There are two forms of it sufficiently distinct from each other to be readily distinguished :—

- (1) *dudhiá* or the “white,” so called on account of the colour of the bloom and its softness as compared with the other. The colour of the rind is generally a light sea-green tinged with yellow, chiefly just above the nodes. The bloom is glaucous or white ; but in some instances, especially on the lower joints, it is dark ; in some cases dark red streaks or blotches appear on individual internodes. The blotches are chiefly prominent on the canes growing on the border of the field and consequently more exposed to the sunshine, which, it is stated, favours the development of the blotches. In such cases the blotches are more or less triangular with a big base and a fine apex pointing towards the root and covering nearly half the surface of each internode. Leaves erect. The cane is brittle, breaking easily with the hand about half an inch above the bud. The rind cannot be peeled off. The edible part in most canes is solid, but sometimes the “cavity filaments” are present. The pith breaks into small pieces on pressure with the fingers and cannot therefore stand bruising. The colour of the pith is slightly greenish. The aerial roots are confined to the two or three lower joints. Under high cultivation the cane grows fairly thicker than is usual among most of the *uñh* races. The



Figure 13.
KUSWAR
(Sultānpur specimen)



Figure 14.
MANGO
(Basti specimen)

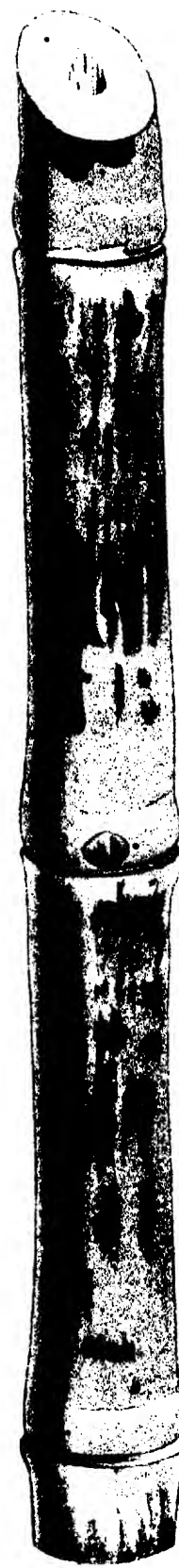


Figure 15.
MOTKI MANGO
(Azamgarh specimen)

juice has a slightly acid reaction. The dry leaves come off clean when detached with the fingers. The buds are small as compared with the size of the cane.

- (2) *sabz kuswār*, also called *bharngā** or *bhuili*. This is grown more abundantly than the *dudhiā*, and resembles the latter very closely in all respects, except the colour, which is green, turning into yellowish green when the cane is ripe, the internodes being covered with brown blotches in parts. A form of green *kuswār*, having its origin in more careful cultivation and liberal treatment, is known as *kajariā*, *kajli*, or *kajari*. The word is derived from *kājal* (soot). This form differs mainly from the *dudhiā* and the typical *sabz kuswār* in being more copiously covered all over with perfectly dark bloom and the rind being more deeply tinged with yellow. The character of the blotches is very similar to that in the *dudhiā*. The local name for *kajri* in Allahabad is *meghwā*. These races are seldom grown separately, always mixed together, the proportion of the green being the largest and that of *kajri* the least. Occasionally they are grown in Sultānpur in conjunction with the *hārā*.

General Remarks.—All forms of *kuswār* have the peculiar property of uniformly splitting into two parts with a knife, which can be likewise split into two and these again into two.

The *kuswār* canes form the main source of the production of *chenihā gur*, the raw sugar most extensively and highly appreciated for refining purposes by the sugar refiners of the Fyzabad Division.

Mango (Plate No. V, Figure No. 14)—Is a perfectly straight cane, thick at the base and beautifully tapering into a point at the top. Very largely cultivated in the greater part of the Gorakhpur and Benares Divisions, and is regarded as the king of canes in those tracts. *Mango* is held in the same degree of esteem in the east as *dhaur* in Rohilkhand and the western districts. The renown of the *gur* of Basti owes its origin to the excellence of *mango* with regard to its quality of sugar. The colour of the stem is whitish green, and the internodes are short and covered with a glaucous bloom. The cane is spotted in parts with brown specks or blotches. When grown in lowlying lands subject to waterlogging, the reddish blotches are more numerous and the cane is then designated as "*lalki mango*" as compared with "*ujarki*" (white *mango*), in which blotches are either absent or scarce.

Cultivation on elevated lands minimizes the appearance of these blotches. The eyes are prominent; the epidermis is soft and easily detachable. The aerial

* This should not be confounded with "*bharangā*," which is a different kind of cane.

roots are found up to the fifth or sixth joint from the bottom. The edible portion of the cane is fairly soft and juicy. The juice is remarkably sweet and delicious. The cane is brittle at the nodes. The leaves are drooping, soft, and smooth, and of a light green colour. This cane suffers great injury from stagnation of water. An important feature of the cane lies in the absolute erectness of the stem with no tendency to bend in the course of the growth, however great a height it may attain under specially liberal treatment. In Jaunpur two forms of *mango* are known, viz., *motki* (Plate No. V, Figure No. 15) (the thick) and *patarki* (Plate No. VII, Figure No. 19) (the thin). The latter, it is stated, never acquires the thickness of the former, although it may grow equally tall under high cultivation. The *motki mango* attains remarkable magnitude of height and thickness in the richer class of soils, in Ballia and Gházipur, where it is known as "*motki*," "*pansári*," or "*motki pansári*," and yields a remarkably high outturn of raw sugar, particularly rich in crystals. *Mango* in Azamgarh is considered a specially valuable cane.

The following proverb, supposed to signify the high appreciation of the cane, is sufficient to indicate the excellence of its merits :—

یار - یارا در آدکھ مہری منگو
آدھی مہی دونگی نہیں ساری کیوں مانگو

The following is a free translation of the text :—

"Although, my sweetheart! thou art dear to me, why shouldst thou ask for a whole cane? I am not prepared even to part with half the cane because it is a *mango* (and therefore so valuable)."

Bharangá (Sanskrit *bhar* = full and *ang* = body, i.e., full-bodied or fat) or *karia* is a tall, green cane, deeper green than any other kind of *ukh*, very nearly approaching the greenness of *paundá*, the name *kariá* being applied on account of its dark green colour; internodes are long. The skin is very soft, and so firmly attached to the pith that it is very difficult to remove it. Small, reddish brown spots are occasionally noticed on the stem. The pith is soft and the juice remarkably delicious, so that this is one of the few kinds of *ukh* which are prized for chewing purposes.

The raw sugar made from it is of fine quality.

Its cultivation is confined to certain parts of the Lucknow and Fyzabad districts.

Reorá or *renrúá* (Plate No. VI, Figure No. 16).—This is one of the prominent canes grown in the Gorakhpur and Benares Divisions. It is a tall and thick cane, and is so called because of its fancied resemblance to "*reud*" (*Ricinus communis*) in thickness and the presence of the central cavity. When in perfection the stem is yellowish green, the epidermis is thick, the pith soft, and



Figure 16.
REORA
(Mirzāpur specimen)



Figure 17.
DHAURA
(Jaunpur specimen)



Figure 18.
HEMJA
(Gorakhpur specimen)

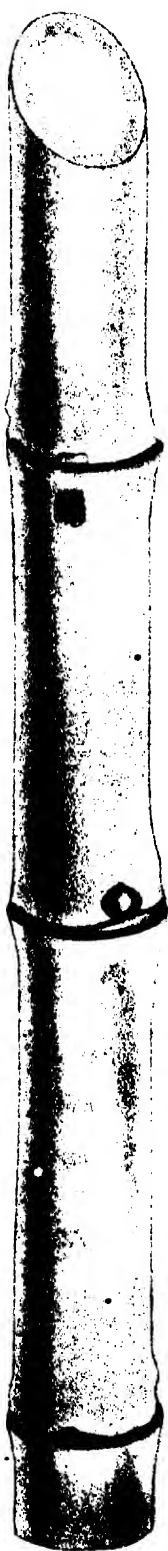


Figure 19.
PATARKI MANGO
(Faunpur specimen)



Figure 20.
REORI
(Benares specimen)



Figure 21.
CHARKAHIA
(Azamgarh specimen)

the cavity filaments luxuriantly developed; dark bloom, not easily rubbed off, sometimes completely covers the yellow of the ground. The eyes are small and depressed; the cane tillers freely. It is brittle at the nodes. The stem is uniformly thick, except towards the top, where the thickness grows less. Occasionally a few red blotches make their appearance on the internodes; but this feature is not prominent. The aerial roots run up to the fifth or sixth joint from the bottom.

The cane is rich in juice, perfectly free from acidity. The leaves are broad and long, and the internodes are small in proportion to the size of the cane. A crop of *reorá* requires very attentive management. It produces raw sugars with large crystals of considerable strength and brilliancy, and the sugar is therefore largely used for refining purposes. As a result of thick sowing an inferior form of this cane known as *reori* (Plate No. VII, Figure No. 20) has been established in Jaunpur and Benares, which resembles the parent in all features except the thickness, which is much less.

Dhaurwá or *dhaurá* (Plate No. VI, Figure No. 17).—A green cane of Azamgarh, harder and thicker than *mango*, but yields a fair outturn of *gur* and requires somewhat less attentive management. Its colour is lighter than that of *mango*, and it thrives best on elevated lands. The rind is hard, and the stem is very brittle at the nodes. The aerial roots grow up to the fourth joint from the base. The skin does not peel off easily, and is thick and flexible. The eyes are prominent. The internodes are patched with dark brown blotches, and the pith is hollow inside. The *dhaurwá* cane should not be confounded with *dhaur*.

A cane similar to *reorá*, called "*hemjá*" or "*hemjawá*" (Plate No. VI, Figure No. 18), is extensively cultivated in the damper parts of Gorakhpur, and yields a high outturn of sugar. It differs from *reorá* in having a shorter, but distinctly thicker, stem, with smaller internodes covered with more prominent blotches of a brown colour and a darker bloom; the upper half of the stalk being usually thicker than the lower half. *Hemjá* is undoubtedly the thickest cane among the *ukh* races, very nearly approaching the thickness of an average *paundá*.

Ledarwá—Is a thick cane of light green colour, rich in juice, having a pith slightly acid reaction; poor in sugar; the epidermis is thick and hard, and the soft. The internodes are long and the eyes prominent. The cane is tough, and the skin firmly attached to the pith. An important feature of the cane is the presence of a marked depression at each joint near the eye. The leaves are long, broad, and drooping.

Charkahiá, *postahiá*, *chamrahiá*, *phatnahiá*, or *chhatphatti* (Plate No. VII, Figure No. 21)—Is a thick, short, and erect cane: so called because the internodes are liable to burst when the cane is nearly ripe, so as to form furrows on their surface. The eyes are very small; epidermis thin, but not easily detachable; pith

soft, and juice very sweet. The stem is very brittle, close-jointed, and zigzag from node to node. The skin is pale green, covered over with thin, brown streaks in parts; aerial roots found on three or four lower joints; bloom dark. The *gur* or *rāb* manufactured from the cane is rich in grain and of excellent colour. An important feature of the cane is its liability to put forth young shoots from the nodes.

Karwā—A straw-coloured cane, having a particularly hard pith; internodes short; bloom dark.

Lakhrā or *neolā*—A form of hard cane of the class “*ukh* canes other than red” known as *lakhrā* or *neolā*; is found in parts of Oudh and Allahabad. Owing to its peculiarities of feature, it cannot be safely classed under any of the groups already mentioned, and is therefore described separately. It is a tall, quick-growing cane, which becomes sufficiently mature for chewing purposes in the month of November, and is of a green colour with a very hard skin, sometimes spotted with pinkish patches in parts. Bloom almost absent, except on a few of the lower joints; eyes prominent, and internodes long. The joints or nodes are markedly swollen. The pith is hard and poor in juice, which has a somewhat acid taste. The aerial roots run sometimes up to the middle of the cane. It can be grown in any class of soil with very little care and trouble, but is never grown singly because of its poor outturn and quality of *gur*. Only a few plants are generally found in the *dhaur* fields of Rohilkhand or the *sarauti* and *baraukhā* crops of Fyzabad. In Fyzabad it was stated that the *gur* from *baraukhā* crops was so rich in crystals that it was difficult to make it into balls (*bhelis*); *lakhrā* was therefore crushed with *baraukhā* in order to correct the juice of the latter, so as to make a sugar which would admit of *bhelis* being prepared. On account of its hardness, the cane is commonly used as a poker for the sugar-boiling furnace.

(b).—The red *ukh* canes.

SERIES IV.—The “*chin*” group.

These canes are most extensively grown in the central and eastern Doab and in the Lucknow Division. The most important of them are—

- (1) the *chan* or *chin* (Plate No. VIII, Figure No. 22), which is the main form cultivated in Aligarh, Etah, Etāwah, and Farrukhabad;
- (2) the *ramui*, which is largely cultivated in the tract of Oudh extending from Unao northward to Bahraich;
- (3) the *baraukhā*, grown to a considerable extent in Cawnpore, Etāwah, Fyzabad, and Basti;
- (4) the *gēglā*, which is found in Mainpuri and Farrukhabad;
- (5) the *lalri* of Bulandshahr and Sahāranpur; and
- (6) the *barāgar* of Fatchpur (Plate No. VIII, Figure No. 23).



Figure 22.
CHIN
(Etawah specimen)



Figure 23.
BARAGAR
(Fatehpur specimen)



Figure 24.
SARETHA
(Meerut specimen)

In all probability these different kinds are identical. A most careful microscopic examination, held at our request by the Director, Botanical Department, Northern India, has failed to discover any difference between their botanical structure.

The different names given to them must therefore be regarded as merely local. From the evidence before us, which consists chiefly of statements of cultivators and observations made by us, all we can say with regard to distinction is, that *chin* is perfectly identical with *ramui*; that it is, on the whole, the thinnest and the shortest; that *barāukhā* is thicker than the *chin* and most apt to bend in course of growth; and that *geglā* is the thickest and most erect of all, with perhaps a lighter colour of the kind. *Lālri* is perhaps the deepest of all, and similar to *chin* in other respects.

The following is a description of the features common to those canes. They are all red or reddish in colour, and have a very hard rind or pith. They are poor in juice as compared with some of the green canes, but yield a rich quality of sugar, reddish in colour. They have a yellow or reddish yellow ring at the node and a central cavity in the stem. The cavity filaments are almost always prominently developed; the aerial roots extend up to several joints from the base upwards, especially in the *barāukhā*. The buds are very prominent; the bloom is often glaucous and occasionally dark. They are not brittle at the joints. The edible portion of the canes is so hard that when chewed it injures the tongue and the jaws. They all grow fairly well in the lighter classes of loamy and *bhur* soils, and suffer little from floods. They are consequently cultivated chiefly on the banks of rivers and in lowlying localities. They are liable to flower in the cold weather, the flower being similar in shape to that of the *sārpāt* grass (*Saccharum ciliare*). The *chan* or *ramui* ratoons particularly well. They are all quick-growing forms of canes, and are ready for crushing in December and January. They require the least attentive cultivation on account of their hardness. The *barāgar* is always crooked, its juice is somewhat acid and aerial roots abundant.

Jondariā—Is a red cane grown in parts of Bahraich. Very likely it is identical with the *ramui* of the Lucknow Division.

Akhri—A tall cane of greenish red colour, having a bent or crooked stem with red rings at the nodes, reported only from Fatehpur.

The internodes are spotted with red patches, and the cane therefore somewhat resembles *arba* in general features. The aerial roots are common at the lower end, and the "cavity filaments" well developed. The epidermis is thin and easily detachable. The stem is not brittle at the joints.

Burāā—Is similar to *barāgar*; eyes depressed.

Saréthá or *sorthá* (Plate No. VIII, Figure No. 24).—This is one of the important tall canes cultivated in the Meerut Division. The stem usually begins to grow crooked when the crop is young. The colour of the epidermis is red; the aerial roots ordinarily run up to the fourth or fifth joint; the pith is hard and somewhat rich in juice, having a little acidity. A red ring at the nodes is very prominent and the cavity filaments well marked; the top leaves are erect and thin. The colour of the bloom is usually dark at the nodes, but glaucous on the internodes. The stem is not brittle at the joints, the skin is thin and the eyes protruding. *Gur* or *ráb* manufactured from *sarethá* is rich in grain; but red in colour. The cane is often grown in conjunction with *dhaur*.

Gholra.—This is a short, thin, and hard cane grown in Dehra Dún. The colour of the skin is red. We have not seen it.

The series of red *ukh* canes described above is represented by Plate No. VIII.

II.—The *ganná* canes.

SERIES V.—The *agaul* canes.

These embrace all the features of the *ganná* canes described on page 4, Chapter II.

The series is represented by Plate No. IX, and in the following pages will be found a full description of each race belonging to this series. These races are—

- | | |
|-------------------------------------|--|
| (1) <i>Agaul</i> or <i>merthi</i> . | (4) <i>Kálá ganná</i> . |
| (2) <i>Dikchan</i> . | (5) <i>Katára</i> , <i>baráukhá</i> , <i>tanká</i> , or <i>mungá</i> . |
| (3) <i>Pansáhi</i> . | (6) <i>Ghorázá</i> . |

Among these the most important races cultivated for the production of sugar are—

(1) The *agaul* or *agraul* of Rohilkhand. This cane is called *gagaul* or "*Barcilly ká ganná*" in Meerut and "*merthi*" (Plate No. IX, Figure No. 25) in Saháranpur and Muzaffarnagar. The names "*Gagaul*" and *Barcilly* owe their origin to the fact that the cane was first imported from Barcilly nearly half a century ago, and acclimatized in the village Gagaul in Meerut district, and the name "*merthi*" to the circumstance that the acclimatized seed-cane was imported from Meerut. *Agaul* is a tall, green, or yellow green cane, very juicy and fairly rich in sugar, and was once highly esteemed both for chewing and sugar-making; but on account of its liability to the fungus disease, *ukthá*, and the failure of many crops during the past few years its cultivation has been gradually dwindling down. The internodes are fairly long and covered with a dark bloom in parts, specially near the joints. The epidermis is thick, but can be detached very easily with a knife to a length of two or three joints. The eyes are prominent and the pith soft with no cavity in it. The cane does not break off clean at the joints when hand force is applied, but bends and splits.



Figure 25.
MERTHI
(Sahāranpur specimen)



Figure 26.
DIKCHAN
(Shāhjahanpur specimen)



Figure 27.
PANSĀHĪ
(Gorakhpur specimen)



Figure 28.
MADRASI PAUNDĀ
(Cawnpur specimen)



Figure 29.
SAHĀRANPŪRI PAUNDĀ
(Sahāranpūr specimen)



Figure 30.
KĀLA GANNĀ
(Aligarh specimen)

The cane of the top is rather flattened as compared with the rest of the stem, which is round. It flourishes best on clay loam, but requires careful cultivation and generous treatment.

(2) *Dikchan* (Plate No. IX, Figure No. 26) of Sháhjahánpur is almost identical with the *agaul* just described, and only differs in being inclined to grow crooked and in having a darker bloom more thickly covering the internodes; also in the aerial roots being more frequent and extending a longer way up the cane.

(3) The *Pansáhi* of Pilibhít, Górákhpur, &c. (Plate No. IX, Figure No. 27).—This is very similar to the *agaul*. Under good cultivation it grows very tall and thick, and the internodes are so thickly covered with a dark bloom that the yellow of the ground is sometimes completely hidden. When ripe, the skin is more deeply tinged with yellow than in the *agaul*. In all other respects it is identical with *agaul*.

(4) The *kálá ganná* of Dehra Dún is very similar in features to the *agaul*. It should not be confounded with the *kálá ganná* or *kálá paundá* of Sháhjahánpur and Aligarh, which is a *paundá* cane.

(5) Among the *ganná* canes the one chiefly grown for chewing is the *katárá* of Fyzabad and South Oudh. Under good cultivation it grows to a considerable height and is well covered with a thick, dark bloom, but the stem is often inclined to grow crooked. All the features of *agaul* and *dikchan* are present in the *katárá*. The local name for *katárá* in Azamgarh and Basti is *baraukhá*, in Allahabad and Fatehpur *tanká*, and in Bundelkhand *mungá*.

(6) *Ghorará*—Is reported as a fairly tall cane, having a hard and thick epidermis. The colour of the skin is light green with fine, dark streaks on the internodes. There is no cavity inside. The cane is stated to be so called because of the dirty colour of its juice, the term “*ghor*” meaning dirty. Further particulars are not known. Its existence has been reported from Saháranpur, and we have not seen it.

III.—The *paundá* canes.

SERIES VI.—The acclimatized canes.

This includes all the canes of the *paundá* class, a general description of which has already been given in Chapter II, pages 4 and 5. Important canes of this group are illustrated in Plate No. X. The canes belonging to this series are enumerated and described below :—

- | | | |
|-------------------------------------|---|---------------------------------------|
| (1) <i>Madrási</i> or <i>thún</i> . | • | (4) <i>Lál</i> or <i>kálá ganná</i> . |
| (2) <i>Bombai</i> . | | (5) <i>Banársi</i> . |
| (3) <i>Saháranpuri</i> . | | (6) <i>Barmi</i> . |

• (7) The Poona *paundá*.

(1) *Madrási* (Plate No. X, Figure No. 28).—This is the kind most commonly cultivated in Lucknow and Cawnpore. The colour of the skin is green, and the stem when mature is generally spotted with red blotches; the aerial roots

extend up to the eighth joint. The epidermis is thick. Under defective cultivation the cane deteriorates and the deteriorated canes are called *Bhojpuri* in Lucknow. In the Sháhjahánpur district the *Bhojpuri* canes are known as *thún*.

(2) *Bombai*.—This is one of the most favoured *paundá* canes of Lucknow. The colour of the skin is greenish yellow, which turns yellow when the cane is fully ripe. This has probably the sweetest juice among the *paundá*, and is famous for this quality. The internodes are thicker than the joints, which are contracted. The eyes are depressed and the skin smooth and covered with a dark bloom.

(3) *Saháranpuri* (Plate No. X, Figure No. 29).—This cane is the most close-jointed of all *paundá* canes, and has the softest pith among them, the juice being remarkably delicious; the colour is green or yellow-green when ripe. A deteriorated form of it is known in Saháranpúr as *gajri*, and is easily recognised by its particularly small size and short joints. It is used in that district for crushing.

(4) *Lál* or *kálá ganná* (Plate No. X, Figure No. 30).—The colour of the skin is a dark red and a form of it has a violet colour; the stem has a pale yellow ring at the joints. The buds are small; the internodes are similar in character to those of the *Bombai* kind. The pith is soft, but the rind is very hard. The pith of the *kálá ganná* of Aligarh is the hardest of all *paundás*.

(5) *Banársi*.—The colour of the cane is reddish yellow, and the stem is covered over with a glaucous bloom. The aerial roots are few. The skin is hard, and the juice not so sweet as that of other kinds of *paundá*.

(6) *Barmi*.—Colour green. The stem is extraordinarily thick and long, and generally covered over with a dark bloom. The eyes are small, the rind is thin and not easily detachable with a knife.

(7) The Poona *paundá* imported from Poona has been grown experimentally at the Cawnpore Farm and in one or two Court of Wards' estates. It grows as tall and thick as the "*Madrási paundá*," but the pith usually becomes hollow and red. It is quicker in germination and growth than the *Madrási*, but subject to lodging on account of the top portion being thicker than the lower part of the stem. It requires more watering than any other cane. It is not fit for chewing on account of its marked inner cavity. It has few aerial roots.

C.—Distribution of the various races of cane among the different districts of the United Provinces.

The following is a statement showing the distribution of the various kinds of cane in the different districts of the United Provinces of Agrá and Oudh. The statement has been so prepared as to show what kinds of cane are grown in each district and in what districts each kind is cultivated. The sign + shows that the kind of cane under which it occurs is cultivated in the district opposite which the sign has been placed. The dots signify absence of the kind of cane

in the districts opposite which they have been given. It will be seen that among the *ukh* canes *dhaur*, *rakhri*, *matná*, *agauli*, *kuswár*, *mango*, *sarauti*, *chin*, *baraukhá*, and *ramui* are grown in the largest number of districts. Among the *ganná* canes *katára*, which is the chief chewing cane, is most extensively cultivated.

The largest number of *paundá* canes is grown in the suburbs of Lucknow. In this statement we have enumerated all the local names with which the numerous races of cane are known in these Provinces.

Some of these names possibly belong to one and the same kind of cane; but they have been given separately because in some cases their identity is doubtful; also because under this arrangement readers not acquainted with all the names of a particular kind of cane will be able to refer to the statement with facility. Where we were certain that a cane was known under different names in different districts, all the names of it have been shown in one and the same column.

Statement showing distribution of the various kinds of sugar

UKA

Canes other

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---------------|--------|---------|-------------------|--------------------------|-----------------|-------------------|---------------|------|--------|---------|---------------------|------|----------|------------------|--------|-------------------|
| | Dhaur. | Dhanri. | Gamli or chā-mar. | Dhaur, kabhri, or jadhā. | Pandariā dhaur. | Rakhrā or rakhrī. | Redi or berī. | Arā. | Einār. | Kindri. | Khatniyā, or railā. | Ilā. | Kāghazi. | Neolā or lakhrī. | Mātnā. | Agauli or agauri. |
| Dehra Dūn | + | | | | | | | | | | | | | | | |
| Sahāranpur | + | | | | | | | | | | | | | | | |
| Muzaffarnagar | + | | + | + | | | | | | | | | | | | |
| Meerut | + | | + | + | | | | | | | | | | | | |
| Bulandshahr | + | | + | + | | | | | | | | | | | | |
| Aligarh | + | | | | | | | | | | | | | | | |
| Muttra | + | | | | | + | | | | | | | | | | |
| Agra | + | | | | | | | | | | | | | | | |
| Farrukhabad | + | | | | | + | | | | | | | | | | |
| Mainpuri | | | | | | | | | | | | | | | + | + |
| Etāwah | | | | | | | | | | | | | | | | |
| Etah | + | | | | | | | | | | | | | | | |
| Bareilly | + | | | | + | + | | | | | | | | | | |
| Bijnor | + | | | + | | + | | | | | | | | | + | + |
| Budaun | + | | | + | | + | | | | | | | | | + | + |
| Moradabad | + | + | | + | | + | | | | | | | | | | |
| Shūhjahānpur | + | | + | | + | + | | | | | | | | + | + | + |
| Pilibhīt | + | | | | + | + | | | | | + | + | | + | + | + |
| Cawnpore | | | | | | + | | | | | + | | | + | + | + |
| Fatehpur | | | | | | + | | | | | | | | | + | + |
| Bānda | | | | | | | | | | | | | | | + | + |
| Hamīrpur | + | | | | | | | | | | | | | | | |
| Allahabad | | | | | | | | | | | | | | | | |
| Jhānsi | + | | | | | | | | | | | | | | | |
| Jalaun | | | | | | + | | | | | | | | | + | + |
| Benares | | | | | | | | | | | | | | | + | + |
| Mirzapur | | | | | | | | | | | | | | | | |
| Jaunpur | | | | | | | | | | | | | | | | |
| Ghāzipur | | | | | | | | | | | | | | | | |
| Ballia | | | | | | | | | | | | | | | | |
| Gorakhpur | | | | | | | | | | | | | | | | |
| Basti | | | | | | | | | | | | | | | | |
| Azamgarh | | | | | | | | | | | | | | + | | |
| Almora | | | | | | | | | | | | | | | | |
| Garhwāl | | | | | | | | | | | | | | | | |
| Naini Tal | | | | | + | + | | | | | | | | | | |
| Lucknow | | | | | + | | | | | | | | | | | |
| Unao | | | | | | | | | | | | | | | | |
| Rae Bareilly | | | | | | | | | | | | | | | | |
| Sitapur | | | | | + | + | | | | | | | | | | |
| Hardoi | + | | | | | | | | | | | | | | + | + |
| Kheri | + | | | | + | + | | | | | | | | | + | + |
| Fyzabad | | | | | | | | | | | | | | + | + | + |
| Gonda | | | | | | | | | | | | | | + | + | + |
| Bahraich | | | | | | | | | | | | | | | | |
| Sultānpur | | | | | | | | | | | | | | | | |
| Partābgarh | | | | | | | | | | | | | | | | |
| Bara Banki | | | | | | | | | | | | | | | | |
| Total | 18 | 1 | 4 | 5 | 7 | 12 | 5 | 3 | 6 | 3 | 4 | 2 | 3 | 8 | 10 | 10 |

cane cultivated in the United Provinces of Agra and Oudh.

CANES.

than red.

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
|--------|--------|---------|--------|---------|--------|---------|---------|--------|-------|-----------|---------|--------|----------|--------|---------|----------|----------|--------|--------|---------|--|----------|
| Mangá. | Karwá. | Machná. | Subhá. | Arkará. | Ránsi. | Bhadwá. | Khajrá. | Karíá. | Bhar. | Bharangá. | Kuswár. | Mango. | Sarauti. | Harwá. | Kewáhi. | Pansári. | Bhanrwá. | Redra. | Hemjá. | Munchá. | Charkabíá, post- abiyá, chamra- hiá, chat- phatti, or phat- nahíá. | Ledarwá. |
| 3 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 8 | 11 | 10 | 5 | 4 | 2 | 3 | 7 | 2 | 2 | 1 | 2 |

Statement showing distribution of the various kinds of sugar

| UKH CANES—(concluded). | | | | | | | | | | | |
|------------------------|-------|--------|--------|--------|----------|----------|----------|--------|--------|----------|---------|
| Red canes. | | | | | | | | | | | |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 |
| | Chin. | Láiri. | Gégíá. | Ramui. | Barakhá. | Jodariá. | Barágar. | Akhrí. | Baurá. | Sarethá. | Gholru. |
| Dehra Dún | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Saháranpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Muzaffarnagar | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Moorut | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bulandshahr | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Aligarh | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Muttra | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Agra | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Farrukhabad | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Mainpuri | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Etáwah | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Etah | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bareilly | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bijnor | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Budaun | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Moradabad | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Sháhjahánpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Pilibhít | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Cawnpore | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Fatehpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bánda | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Hamírpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Allahabad | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Jhánsi | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Jalaun | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Benares | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Mirzapur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Jaunpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gházípur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Ballia | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gorakhpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Basti | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Azamgarh | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Almora | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Garhwál | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Naini Tal | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Lucknow | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Unao | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Rae Bareli | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Sitapur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Hardoi | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Kheri | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Fyzabad | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Gonda | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bahraich | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Sultánpur | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Partábgarh | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Bara Banki | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. |
| Total | 16 | 8 | 8 | 7 | 11 | 2 | 1 | 1 | 1 | 5 | 1 |

D.—Merits of the different kinds of cane.

Reference has already been made briefly to the general qualities of several kinds of cane in the section treating of their description. With a view to determining specially the merits of different races described, we carried out in the crushing seasons of 1897-98 and 1898-99 a large number of crop-cutting experiments in different parts of the country under our personal supervision, and had similar experiments made in other districts by the *kánúngo* staff. The figures of the experiments reported by the *kánúngos* were in many cases unacceptable on account of being obviously wrong. Such figures were carefully rejected. Canes that are not grown singly could not of course be experimented on, with the special object of determining the average outturn of *gur* they are capable of yielding per acre, and this is our apology for the omission to give the outturn of *gur* in the case of certain kinds of cane. Such kinds are, however, unimportant, being grown in mixtures on a small scale. None of the canes cultivated to any extent have really been omitted. We attach two statements—one (A) showing the average outturn per acre of the more important forms of cane, with its details; and the other (B) showing the highest outturn that these canes are capable of yielding, with further details thereof. The figures in both statements are based on the actual experiments referred to above. It must be borne in mind that it is unsafe to draw any absolutely definite conclusions about the merits of canes from the results of experiments carried out in two seasons (and in fact in most cases in one season only, 1898-99), both of which, by the way, happened to be exceptionally favourable. But with a careful investigation of the views held by cultivators with regard to the value of the different kinds, supplemented by the facts shown by our own experiments, we shall attempt to say a few words regarding the more important canes, dealing first with the *ukh* canes.

*(a)—The *ukh* canes.*

The percentage of juice expressed.—The quantity of juice obtained depends in a great measure upon the efficiency of the mills. Generally speaking, the mills commonly used in the Meerut Division extract a larger percentage of juice than those employed in the east, which include the inferior two-roller iron mills and the old-fashioned stone and wooden mills. The stone mills have the disadvantage of wearing in the course of work, and the juice they extract is usually full of particles of stone. With these mills a high weight of juice is therefore not uncommonly obtained at the expense of purity, and the *gur* made from it is proportionately impure. It is clear that, where these mills are employed, the weight of juice obtained from a certain weight of a certain kind of cane is not a true index of its merits. Considering that different mills are used in different parts of the country; and that our figures of average are based on the results of experiments tried with all kinds of mills, the averages must be considered to denote the quantities that the cultivator actually gets, and not those that the various kinds of cane are capable of yielding. Our experiments only confirm the

popular idea, that the kinds which yield an abundance of juice do not generally produce a proportionately high outturn of *gur*; or, in other words, where juice is abundant the percentage of sugar in it is low.

By looking into Statement A it will appear that *bori* has yielded the highest percentage of juice, viz., 61·5; but the produce of *gur* obtained from it is low (only 25·79 maunds per acre) as compared with most of the other forms of canes. Moreover, in individual cases (see Statement B) the average outturn of juice yielded by *bori* has been exceeded by *pansári*, *sarethá*, *matná*, *lálri*, and *dhaur*. These circumstances do not entitle *bori* to a place in the rank of the best *ukh* races. Its cultivation, besides, is by no means extensive.

Dhaur, *kinár*, *kewáhi*, and *hemjá* are very juicy canes, yielding on the average between 55 and 60 per cent. of juice with the mills commonly used, the first two having, in individual instances, yielded a little over 63 and 65 per cent. of juice respectively. *Arbi*, a degenerated form of *bori*, comes very close to the races just named in this respect, but does not yield a particularly high outturn of *gur*, which, on the other hand, is very poor in quality. The red canes *sarethá*, *lálri*, *jondariá*, *geglá*, and *ramui* also compare favourably with *kinár*, *kewáhi*, *hemjá*, and *dhaur* as regards yield of juice, but their *gur* is generally of a much darker colour, and therefore comparatively inferior. *Pandariá*, *rakhri*, *kuswár*, *pansáhi*, *matná*, *sarauti*, *reorá*, *chin*, and *baraukhá* are among the largely grown kinds of cane yielding between 50 and 55 per cent. of juice. The juice giving the largest average yield of *gur* (above 20 per cent.) has been found to be that of *karwá*, *bharangá*, *hemjá*, and *lálri*, the first two being grown to a very limited extent. Among the largely cultivated canes *dhaur*, *matná*, *sarauti*, *harwá*, *kewáhi*, *reorá*, *hemjá*, *chin*, and *ramui* have also been found in individual instances to yield juice which on boiling gave more than 20 per cent. of *gur*.

The juice of *mango*, *kewáhi*, *pansári*, *reorá*, *geglá*, and *khatuiyá* has been found on the average to yield between 18 and 20 per cent. of *gur*—a limit which has in exceptional cases been attained by the juice of *sarethá*, *pandariá*, *kinár*, *kuswár*, and *baraukhá*. The *gur* of *khatuiyá* is, however, notoriously poor in quality.

In the case of *dhaur*, *pandariá*, *bodi*, *kinár*, *matná*, *kuswár*, *sarauti*, *harwá*, *chin*, *ramui*, *baraukhá*, and *sarethá* the juice has been found to yield between 16 and 18 per cent. of *gur*.

Average percentage of gur in cane.—*Kewáhi*, *hemjá*, *lálri*, and *geglá* have on the average yielded more than 11 per cent. of *gur*. The figure has also been exceeded in exceptional cases by *dhaur*, *pandariá*, *kinár*, *matná*, *kuswár*, *sarauti*, *reorá*, and most of the red canes. *Bodi*, *kinár*, and *karwá* have produced between 10 and 11 per cent. of *gur*, and so have, in special cases, *mango* and *baraukhá*. *Dhaur*, *kuswár*, *mango*, *sarauti*, *pansári*, *reorá*, and most of the red canes have yielded between 9 and 10 per cent. of *gur*. In the case of the remaining *ukh* races the outturn of *gur* has been below 9 per cent. of the weight of cane.

The percentage of sugar in juice.—We cannot attach much importance to the figures determined by Twadell's hydrometer, as the results obtained are known

to be only approximately correct, and they necessarily vary according to age of the canes experimented with and several other conditions. However, from the figures before us we infer that the juice containing the highest percentage of sugar (above 18 per cent.) is that of *matná* and *keráhi*; that the juice of nearly all red canes is also very rich; and that of the *ganná* races generally poor in sugar. A high percentage of sugar also exists in the *paundá* canes.

Turning to the average yield of *gur* per acre—which, as a matter of fact, is the most important factor in determining the merits of the various races,—we find that the *hemjá* stands first in the list with the remarkably high outturn of 71 maunds of *gur* per acre, the percentages of *gur* in juice and in cane being also the highest. Only one experiment could, however, be carried out with this cane in the course of our enquiry, and on the basis of that experiment alone we do not feel justified in announcing that it is the best cane in the United Provinces. Its cultivation is limited to parts of Gorakhpur and the adjoining districts, where it is very highly thought of. There is therefore no doubt that this form of cane calls for special attention, and is deserving of a full trial in other cane-growing tracts.

The kind which draws our attention next on Statement A is the *pansári*, with an average outturn of over 49 maunds of *gur* based on the results of no less than 18 experiments, in one of which it has yielded as much as 60½ maunds of *gur* to the acre. We can therefore have no hesitation in declaring it to be one of the finest races. It is grown chiefly in Ballia and Gházipur, and its cultivation might with advantage be tried in other districts.

Khatuigá and *reorá* occupy the next two places with reference to the quantity of the outturn; but, as stated before, the *gur* of *khatuigá* is so poor in quality as to throw it entirely out of consideration.

Reorá holds a well-deserved high position among the *red* races of the East.

Kinárá with an average of nearly 39 maunds per acre, is a famous cane of the Meerut and Rohilkhand Divisions; much esteemed everywhere in these tracts, but seldom grown singly on account of the reddish colour of the *gur* it produces. In one instance it has yielded 41½ maunds.

Sarethá stands first among the red canes on account of its high outturn of *gur*, yielding on an average about 38 maunds of *gur* per acre, and found under specially favourable conditions to produce as much as 42½ maunds. Its cultivation is, however, practically confined to the Meerut Division. Probably its introduction in the tracts which chiefly grow red canes, such as the Eastern Doáb and the Lucknow Division, would be beneficial.

Kuswár is one of the more famous races of the east, cultivated largely in the districts of Sultánpur and Partábgarh. The *gur* obtained from it fetches a high price on account of its special suitability for the manufacture of *pakki chini*. The highest outturn of *gur* produced per acre is 44 maunds, and the average yield 35 maunds.

Sarauti and *mango* are the leading races of the eastern parts of these Provinces. They are extensively grown in the Benares and Gorakhpur Divisions and are classed by cultivators among the finest races. The former is more juicy than the latter, but poorer in sugar. The raw sugars manufactured from *sarauti* are rich in grain, though reddish in colour. *Sarauti* is highly esteemed by cultivators as it thrives well at less expense and labour and tillers freely; whereas the cultivation of *mango* is comparatively expensive. The former has been found to yield an average outturn of 35 maunds and the latter 25 maunds; the highest outturn of the former being 43 and of the latter 34 maunds.

Dhaur is the most extensively cultivated cane of the Province of Agra, and is chiefly grown in the Meerut and Rohilkhand Divisions, sometimes singly and often in mixtures. The *gur* obtained from this cane is particularly good in respect of colour and grain. It produces, according to the experience gained in our experiments, nearly 35 maunds of *gur* per acre on an average. In one instance it has been found by us to produce 55 maunds per acre, but the crop experimented on was grown under a remarkably high agricultural condition.

Dhumar has in one case yielded 36 maunds of *gur*; but its quality is always so inferior that the cane is considered of little value.

Chin and *matná* occupy an extensive area of land in the country, the former being cultivated chiefly in the central and eastern Doáb, and the latter in the north-west of Oudh and the eastern parts of the Doáb and Rohilkhand. Both the races yield a large outturn of *gur* or *ráb* of excellent quality. As a matter of fact, however, the *gur* made from these two kinds of canes is seldom used for refining purposes; but the *ráb* of both is regarded as a splendid raw sugar for the manufacture of *khánd*, the *ráb* of *matná* being considered superior owing to its lighter colour. The average yield of *matná* comes to 30·3 maunds of *gur* and the highest to 40 maunds. *Chin*, on the other hand, gives a poorer outturn, only 26 maunds on the average. The highest outturn of *chin* obtained in our experiments amounted to 34·70 maunds. The form of *chin* known as *ramui* in Oudh yields nearly 3½ maunds more *gur* per acre on the average than *chin* in lighter soils of the Doáb. In one case *ramui* has been reported to yield no less than 43 maunds of *gur* per acre.

The rest of the *ukh* races produce lower outturns than those discussed above, and are therefore not equally in favour with the agricultural public. They do not call for special notice.

(b)—The *ganná* canes.

Among the *ganná* races the largest outturns have been obtained from *tanká*, *pansáhi*, and *katárá*, other canes yielding about the same outturn as some of the inferior races of *ukh*. *Pansáhi* enjoys some reputation as a sugar-producing cane in Gorakhpur. The remaining *ganná* canes are chiefly grown for chewing.

(c)—The *paundá* canes.

The merits of the Saháranpur *paundá*, which is the only *paundá* cane used for crushing, are sufficiently clear from the high average outturn of 66·84 maunds

of *gur* to the acre, the highest yield being 84½ maunds. The highest percentage of juice yielded by the Saháranpur *paundá* was 77.39. On account of its remarkable richness in juice and softness of pith it is very largely used for chewing.

(A).—Statement showing average outturn per acre of such races of sugarcane as are grown singly in the United Provinces of Agra and Oudh.

| Serial number. | Name of cane. | Number of experiments carried out. | Number of districts in which the experiments were carried out. | Average yield per acre in maunds. | | | Percentage of— | | |
|------------------------------|----------------------|------------------------------------|--|-----------------------------------|------------------|----------------|----------------|---------------|--------------|
| | | | | Weight of cane. | Weight of juice. | Weight of gur. | Juice in cane. | Gur in juice. | Gur in cane. |
| <i>Canes other than red.</i> | | | | | | | | | |
| 1 | Dhanr | 29 | 11 | 362.79 | 200.74 | 34.94 | 55.33 | 17.38 | 9.62 |
| 2 | Dhumar | 1 | 1 | 390.00 | 216.00 | 36.00 | 53.82 | 17.14 | 9.23 |
| 3 | Pandariá | 6 | 2 | 320.97 | 175.29 | 28.27 | 54.63 | 16.13 | 8.81 |
| 4 | Rakhri or Rakhri. | 5 | 3 | 278.53 | 151.11 | 23.07 | 54.25 | 15.26 | 8.28 |
| 5 | Bodi | 3 | 2 | 246.70 | 151.86 | 25.79 | 61.55 | 16.98 | 10.45 |
| 6 | Arbi | 1 | 1 | 360.00 | 210.00 | 30.60 | 58.33 | 14.57 | 8.50 |
| 7 | Kinár | 2 | 2 | 367.35 | 219.44 | 38.88 | 59.74 | 17.72 | 10.58 |
| 8 | Khatniyá or Raibá. | 1 | 1 | 485.00 | 275.00 | 42.30 | 46.39 | 18.80 | 8.72 |
| 9 | Matná | 15 | 6 | 366.45 | 186.42 | 30.30 | 50.87 | 16.25 | 8.27 |
| 10 | Karwá | 1 | 1 | 262.70 | 132.20 | 27.80 | 50.32 | 21.03 | 10.58 |
| 11 | Bápsi | 3 | 1 | 289.56 | 143.90 | 24.03 | 49.69 | 16.70 | 8.29 |
| 12 | Bhadwá | 2 | 1 | 372.72 | 147.84 | 26.24 | 49.16 | 17.75 | 8.73 |
| 13 | Karrá | 1 | 1 | 215.00 | 127.50 | 21.20 | 59.30 | 16.63 | 9.86 |
| 14 | Bharangá | 1 | 1 | 367.50 | 162.00 | 33.00 | 44.08 | 20.37 | 8.98 |
| 15 | Kuswár | 9 | 5 | 373.82 | 202.50 | 35.04 | 54.17 | 17.80 | 9.37 |
| 16 | Mango | 8 | 4 | 272.42 | 131.26 | 25.41 | 48.18 | 19.36 | 9.33 |
| 17 | Sarauti | 17 | 8 | 384.14 | 206.99 | 35.76 | 53.88 | 17.28 | 9.31 |
| 18 | Hará or Harwá | 2 | 2 | 336.00 | 154.72 | 25.40 | 46.05 | 16.42 | 7.56 |
| 19 | Kewáhi | 7 | 3 | 258.75 | 152.13 | 28.70 | 58.79 | 18.87 | 11.09 |
| 20 | Pansári | 18 | 2 | 494.21 | 267.61 | 49.18 | 54.15 | 18.38 | 9.95 |
| 21 | Reorá | 13 | 5 | 431.74 | 230.60 | 41.83 | 53.49 | 18.14 | 9.70 |
| 22 | Hemjá | 1 | 1 | 561.40 | 328.40 | 71.00 | 58.50 | 21.62 | 12.65 |
| 23 | Munchá | 6 | 2 | 340.17 | 174.86 | 29.99 | 51.40 | 17.15 | 5.82 |
| <i>Red canes.</i> | | | | | | | | | |
| 24 | Chin | 35 | 11 | 278.07 | 148.06 | 26.00 | 53.25 | 17.56 | 9.35 |
| 25 | Látri | 3 | 2 | 278.72 | 160.92 | 32.62 | 57.73 | 20.27 | 11.70 |
| 26 | Géglá | 4 | 2 | 240.56 | 141.01 | 27.44 | 56.73 | 19.46 | 11.04 |
| 27 | Ramui | 12 | 6 | 302.14 | 167.47 | 29.42 | 55.43 | 17.57 | 9.74 |
| 28 | Baraukhá | 12 | 5 | 248.39 | 128.55 | 22.77 | 51.75 | 17.71 | 9.17 |
| 29 | Jondariá | 2 | 1 | 314.00 | 180.58 | 27.09 | 57.51 | 15.00 | 8.63 |
| 30 | Barágar | 3 | 1 | 221.13 | 113.46 | 18.80 | 51.31 | 16.57 | 8.50 |
| 31 | Baurá | 1 | 1 | 181.10 | 75.00 | 14.60 | 41.51 | 19.47 | 8.06 |
| 32 | Sarethá | 6 | 3 | 379.49 | 210.58 | 37.58 | 55.49 | 17.85 | 9.90 |
| <i>"Ganná" canes.</i> | | | | | | | | | |
| 33 | Kálá ganná | 1 | 1 | 270.00 | 191.25 | 29.70 | 70.83 | 15.53 | 11.00 |
| 34 | Agaul | 3 | 3 | 372.70 | 190.54 | 27.42 | 51.12 | 14.39 | 7.36 |
| 35 | Dikhan | 3 | 2 | 323.62 | 181.22 | 30.39 | 56.00 | 16.77 | 9.39 |
| 36 | Ghorará | 1 | 1 | 320.50 | 166.93 | 23.77 | 52.08 | 14.24 | 7.42 |
| 37 | Tanká | 2 | 1 | 531.66 | 294.00 | 60.73 | 55.29 | 20.66 | 11.42 |
| 38 | Katárá | 3 | 2 | 414.97 | 244.71 | 42.63 | 58.97 | 17.42 | 10.27 |
| 39 | Pansáhi | 3 | 1 | 468.51 | 222.17 | 48.46 | 47.42 | 21.28 | 10.34 |
| <i>"Paundá" canes.</i> | | | | | | | | | |
| 40 | Paundá (Saháranpur). | 3 | 2 | 601.48 | 434.91 | 66.84 | 72.31 | 15.37 | 11.11 |

(B).—Statement showing the highest outturns of juice and gur obtained from different kinds of cane grown in the United Provinces, and the percentage of sugar contained in their juice.

| Serial number. | Name of cane. | Number of experiments carried out. | Number of districts in which the experiments were carried out. | Highest percentage of juice in cane expressed by cultivator. | Highest percentage of gur in juice. | Highest percentage of gur in cane. | Highest outturn of gur obtained per acre in maunds. | Percentage of sugar in juice as determined by Twadell's hydrometer. | | Percentage of sugar in juice as determined by chemical analysis. | |
|--------------------------|------------------------|------------------------------------|--|--|-------------------------------------|------------------------------------|---|---|------|--|-------|
| | | | | | | | | From— | To— | From— | To— |
| (1) UKH RACES. | | | | | | | | | | | |
| (a) Cane other than red. | | | | | | | | | | | |
| 1 | Dhaur ... | 29 | 11 | 63.26 | 21.42 | 11.73 | 55.00 | 12.5 | 16 | ... | 13.32 |
| 2 | Dhauri ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 3 | Chāmār ... | ... | ... | ... | ... | ... | ... | 14 | 15.5 | ... | ... |
| 4 | Dhumār ... | 1 | 1 | 63.82 | 17.14 | 9.23 | 36.00 | ... | 17 | ... | ... |
| 5 | Pandariā ... | 6 | 2 | 60.18 | 18.20 | 11.20 | 42.51 | 16.5 | 17 | ... | ... |
| 6 | Rakhrā or Rakhrī. ... | 5 | 3 | 59.41 | 15.26 | 8.35 | 35.50 | ... | 16 | ... | ... |
| 7 | Bodī Bori ... | 3 | 2 | 62.50 | 17.63 | 10.79 | 38.00 | 16 | 17 | ... | ... |
| 8 | Arbā ... | 1 | 1 | 58.33 | 14.57 | 8.50 | 30.60 | 15 | 15.5 | ... | ... |
| 9 | Kinār ... | 2 | 2 | 65.42 | 18.75 | 11.06 | 41.51 | 14 | 15.5 | ... | ... |
| 10 | Kināri ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 11 | Khatniyā or Raihā. ... | 1 | 1 | 49.39 | 18.80 | 8.72 | 42.30 | ... | 14 | ... | ... |
| 12 | Pilā * ... | ... | ... | 55.00 | ... | ... | ... | ... | ... | ... | ... |
| 13 | Kāghzi ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 14 | Neolā* or Lakhrā. ... | ... | ... | ... | ... | ... | ... | 16.5 | 17 | ... | ... |
| 15 | Matnā ... | 15 | 6 | 68.75 | 21.21 | 11.02 | 40.00 | 16.5 | 18.5 | ... | 13.36 |
| 16 | Agauli or Agnuri. ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 17 | Mankā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 18 | Karwā ... | ... | 1 | 50.32 | 21.03 | 10.58 | 27.80 | ... | ... | ... | ... |
| 19 | Machnā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 20 | Subā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 21 | Arkarā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 22 | Bānsi ... | 3 | 1 | 61.80 | 18.33 | 11.33 | 33.00 | ... | ... | ... | ... |
| 23 | Bhadwā ... | 2 | 1 | 49.74 | 21.11 | 10.00 | 38.00 | ... | ... | ... | ... |
| 24 | Khajrā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 25 | Karrā ... | 1 | 1 | 59.30 | 16.63 | 9.86 | 21.20 | ... | ... | ... | ... |
| 26 | Bhar ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 27 | Bharangā ... | 1 | 1 | 44.08 | 20.37 | 8.98 | 33.00 | ... | ... | ... | ... |
| 28 | Kuswār ... | 9 | 5 | 61.61 | 19.75 | 11.42 | 44.00 | ... | 14.5 | ... | ... |
| 29 | Mango ... | 8 | 4 | 60.00 | 20.00 | 10.52 | 34.00 | 13 | 18 | 11.73 | 13.53 |
| 30 | Sarauti ... | 17 | 8 | 56.68 | 21.42 | 11.71 | 43.12 | 15 | 17 | ... | ... |
| 31 | Harwā ... | 2 | 2 | 48.08 | 21.36 | 9.04 | 27.35 | ... | 16 | ... | ... |
| 32 | Kewāhi ... | 7 | 3 | 56.25 | 20.73 | 11.46 | 34.43 | 15.5 | 18.5 | ... | ... |
| 33 | Pansāri ... | 18 | 2 | 68.75 | 21.74 | 11.98 | 60.50 | 17 | 18.5 | ... | ... |
| 34 | Dhaurwā ... | ... | ... | ... | ... | ... | ... | 16.5 | 17 | ... | ... |
| 35 | Reorā ... | 13 | 5 | 61.19 | 20.28 | 11.28 | 52.75 | 13 | 16 | ... | ... |
| 36 | Hemjā ... | 1 | 1 | 58.50 | 21.62 | 12.65 | 71.00 | 16.5 | 18 | ... | ... |
| 37 | Mumchā ... | 6 | 2 | 53.84 | 20.82 | 11.97 | 42.19 | 17.5 | 18 | ... | ... |
| 38 | Charkahiā* ... | ... | ... | 48.80 | ... | ... | ... | 14 | 16 | ... | ... |
| 39 | Ledarwā ... | ... | ... | ... | ... | ... | ... | 15.5 | 16 | ... | ... |

NOTE.—Where columns are blank it should be understood that figures are not available.

*Only a small quantity of this cane was crushed and the juice weighed: the percentage of juice shown in this statement has been calculated from weight so recorded.

(B).—Statement showing the highest outturns of juice and gur obtained from different kinds of cane grown in the United Provinces, and the percentage of sugar contained in their juice—(concluded).

| Serial number. | Name of cane. | Number of experiments carried out. | Number of districts in which the experiments were carried out. | Highest percentage of juice in cane expressed by cultivator. | Highest percentage of gur in juice. | Highest percentage of gur in cane. | Highest outturn of gur obtained per acre in maunds. | Percentage of sugar in juice as determined by Twadell's hydro- meter. | | Percentage of sugar in juice as determined by chemical analysis. | |
|--------------------------------|-----------------|---------------------------------------|--|--|--|---------------------------------------|---|---|------|---|-------|
| | | | | | | | | From— | To— | From— | To— |
| (1) UKH RACES —(concluded). | | | | | | | | | | | |
| (b) Red canes. | | | | | | | | | | | |
| 40 | Chin ... | 35 | 11 | 57.41 | 21.28 | 11.63 | 34.70 | 16 | 18 | ... | ... |
| 41 | Lālri ... | 3 | 2 | 65.82 | 21.83 | 11.75 | 53.75 | ... | 18 | ... | ... |
| 42 | Géglā ... | 4 | 2 | 59.49 | 21.56 | 11.45 | 37.62 | ... | ... | ... | ... |
| 43 | Ramui ... | 12 | 6 | 60.00 | 21.00 | 11.29 | 43.00 | 15 | 18 | ... | ... |
| 44 | Baraukhā ... | 12 | 5 | 58.83 | 19.92 | 10.79 | 34.62 | 15.5 | 18.5 | ... | ... |
| 45 | Jondariā ... | 2 | 1 | 60.56 | 15.51 | 8.68 | 27.09 | ... | ... | ... | ... |
| 46 | Barāgar ... | 3 | 1 | 53.97 | 18.76 | 10.42 | 21.87 | ... | ... | ... | ... |
| 47 | Akhri ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 48 | Baurā ... | 1 | 1 | 41.41 | 19.47 | 8.06 | 14.60 | ... | ... | ... | ... |
| 49 | Sarethā ... | 6 | 3 | 69.35 | 20.00 | 12.38 | 42.50 | ... | 18 | ... | ... |
| 50 | Ghaulri ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| (2) GANNĀ CANES. | | | | | | | | | | | |
| 51 | Kālā gannā ... | 1 | 1 | 70.83 | 15.53 | 11.00 | 29.70 | ... | ... | ... | ... |
| 52 | Agaul ... | 3 | 3 | 54.54 | 15.14 | 8.26 | 31.81 | 13 | 14 | ... | ... |
| 53 | Dikchan ... | 3 | 2 | 61.47 | 17.5 | 9.90 | 32.25 | 13 | 14.5 | ... | 10.99 |
| 54 | Ghorarā ... | 1 | 1 | 52.08 | 14.24 | 7.42 | 23.77 | ... | ... | ... | ... |
| 55 | Mugā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 56 | Tankā ... | 2 | 1 | 55.55 | 20.66 | 11.42 | 65.00 | 16 | 17 | ... | ... |
| 57 | Katārā ... | 3 | 2 | 63.54 | 19.54 | 12.08 | 51.25 | 15.5 | ... | ... | ... |
| 58 | Pansāhi ... | 3 | 3 | 68.05 | 21.88 | 12.57 | 70.00 | 15 | 17 | ... | ... |
| (3) PAUNDA CANES. | | | | | | | | | | | |
| 59 | Sahāranpuri ... | 3 | 2 | 77.39 | 18.82 | 14.24 | 84.75 | ... | 16 | 13.54 | 14.92 |
| 60 | Gajri ... | ... | ... | ... | ... | ... | ... | ... | 18 | ... | ... |
| 61 | Thun ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 62 | Kālā paundā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 63 | Madrāsi * | ... | ... | 57.52 | ... | ... | ... | ... | 16 | ... | ... |
| 64 | Poonā ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 65 | Bombai ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 66 | Barmi ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 67 | Banāresi ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

NOTE.—Where columns are blank it should be understood that figures are not available.

* Only a small quantity of this cane was crushed and the juice weighed; the percentage of juice shown in this statement has been calculated from weight so recorded.

E.—Measurements of the different kinds of cane.

The following statement shows the measurements of the various kinds of cane. Numerous canes of each kind were measured in each district where the kind is cultivated, and their measurements noted in each case :—

Statement showing measurements of the different kinds of sugarcane grown in the United Provinces of Agra and Oudh.

| Serial number. | Name of cane. | Maximum height. | Average height. | Maximum number of inter-nodes. | Maximum thickness— | | | Maximum breadth of leaves in the centre. |
|----------------|-------------------|-----------------|-----------------|--------------------------------|--------------------|----------------|--------------|--|
| | | | | | At the top. | In the middle. | At the base. | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | (a) Ukh Cane. | Feet. | Feet. | | Inches. | Inches. | Inches. | Inches. |
| 1 | Dhaur ... | 7½ | 5 | 27 | 2½ | 3½ | 3 | 1½ |
| 2 | Dhauri ... | ... | ... | ... | ... | ... | ... | ... |
| 3 | Chámár ... | 6 | 4 | 25 | 2 | 2½ | 2 | 1 |
| 4 | Dhumar ... | 8 | 5½ | 27 | 3 | 3½ | 3½ | 1½ |
| 5 | Pandaria ... | 8½ | 5½ | 26 | 3½ | 3½ | 3 | 1½ |
| 6 | Rakhrá ... | 6 | 4½ | 25 | 2½ | 2½ | 2½ | 1½ |
| 7 | Bodi ... | 5½ | 4½ | 25 | 2½ | 3 | 3 | 1½ |
| 8 | Arbá ... | 7½ | 5½ | 24 | 2½ | 2½ | 2½ | 1½ |
| 9 | Kinár ... | 5 | 3½ | 24 | 1½ | 2 | 2 | 1½ |
| 10 | Kinári ... | 5½ | 4 | 22 | 1 | 1½ | 1½ | 1 |
| 11 | Khatuiyá (Raihá), | 8½ | 5 | 30 | 2½ | 3½ | 2½ | 1½ |
| 12 | Pilá ... | 4 | 3½ | 12 | 1½ | 2½ | 2 | 1 |
| 13 | Kághazi ... | 5 | 4½ | 25 | 1½ | 2 | 2 | 1½ |
| 14 | Neolá or Lakhrá, | 8 | 6½ | 28 | 2 | 2½ | 3 | 1½ |
| 15 | Matná ... | 6½ | 3½ | 36 | 3½ | 3½ | 3 | 1½ |
| 16 | Agauli or Agauri, | 5½ | 4½ | 21 | 2½ | 2½ | 2½ | 1 |
| 17 | Mangá ... | 7½ | 6 | 29 | 2 | 1½ | 2½ | 1 |
| 18 | Karwá ... | 4½ | 4½ | 18 | 2½ | 3 | 2½ | 1½ |
| 19 | Machná ... | 2½ | 2 | 11 | 2 | 2½ | 2½ | 1 |
| 20 | Subiá ... | 6 | 5 | 19 | 1½ | 2 | 2 | 1 |
| 21 | Arkará ... | 5½ | 5½ | 19 | 2 | 1½ | 2½ | 1½ |
| 22 | Bápsi ... | 4½ | 4 | 20 | 1½ | 2½ | 2½ | 1 |
| 23 | Bhadwá ... | 5½ | 5 | 24 | 2 | 2½ | 2½ | 1½ |
| 24 | Khajrá ... | 5½ | 4½ | 25 | 2½ | 2½ | 3 | 1½ |
| 25 | Karrá ... | 5 | 4½ | 20 | 1½ | 2 | 2 | 1 |
| 26 | Bhar ... | 5 | 4 | 16 | 1½ | 2 | 2 | 1 |
| 27 | Bharangá ... | 6 | 5½ | 19 | 0½ | 1 | 0½ | 1 |
| 28 | Kuswár ... | 6½ | 5½ | 36 | 3 | 3½ | 4 | 1½ |
| 29 | Mango ... | 7½ | 5½ | 37 | 3½ | 3½ | 3½ | 1½ |
| 30 | Saranti ... | 6½ | 5 | 26 | 2 | 2½ | 2½ | 1½ |
| 31 | Harwá ... | 5½ | 4½ | 23 | 2 | 2½ | 2½ | 1 |
| 32 | Kewáhi ... | 6 | 4½ | 24 | 2½ | 3 | 2 | 1 |
| 33 | Pansári ... | 6½ | 6 | 24 | 2 | 2½ | 2½ | 1½ |
| 34 | Dhaurwá ... | 7 | 5 | 17 | 3½ | 3½ | 3½ | 1½ |
| 35 | Reorá ... | 6 | 4½ | 27 | 3 | 3½ | 3½ | 1½ |
| 36 | Ilemjá ... | 5½ | 4½ | 28 | 3½ | 3½ | 3½ | 1½ |
| 37 | Mumchá ... | 4½ | 3½ | 20 | 1½ | 1½ | 1 | 1 |
| 38 | Charkahiá ... | 5½ | 4 | 25 | 2½ | 2½ | 2½ | 1 |
| 39 | Ledarwá ... | 6½ | 6½ | 25 | 2½ | 2½ | 2½ | 1½ |
| 40 | Chin ... | 7½ | 5½ | 29 | 1½ | 2 | 2 | 1½ |
| 41 | Láiri ... | 7½ | 5½ | 26 | 1½ | 2 | 2 | 1½ |
| 42 | Góglá ... | 7½ | 6½ | 25 | 2 | 2½ | 2½ | 1½ |
| 43 | Ramui ... | 8 | 5½ | 28 | 1½ | 2 | 2 | 1½ |

NOTE.—Where columns are blank it should be understood that measurements are not available.

Statement showing measurements of the different kinds of sugarcane grown in the United Provinces of Agra and Oudh—(concluded).

| Serial number. | Name of cane. | Maximum height. | Average height. | Maximum number of internodes. | Maximum thickness— | | | Maximum breadth of leaves in the centre. |
|----------------|-----------------------------------|-----------------|-----------------|-------------------------------|--------------------|----------------|--------------|--|
| | | | | | At the top. | In the middle. | At the base. | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| | (a) <i>Ukh</i> CANE —(concluded). | Feet. | Feet. | | Inches. | Inches. | Inches. | Inches. |
| 44 | Barankhá ... | 7½ | 6½ | 22 | 2 | 2½ | 2½ | 1½ |
| 45 | Jondariá ... | 7½ | 6 | 21 | 1½ | 2 | 2 | 1½ |
| 46 | Barágay ... | 9 | 6 | 18 | 1½ | 1½ | 2 | 1½ |
| 47 | Akhri ... | 7 | 6 | 21 | 1½ | 2 | 2 | 1 |
| 48 | Baurá ... | 6½ | 5½ | 20 | 1½ | 1½ | 2 | 1½ |
| 49 | Sarethá ... | 9 | 6½ | 28 | 2½ | 3 | 3 | 1½ |
| 50 | Ghaulpu ... | 6 | 5 | 20 | 1½ | 2 | 2 | 1½ |
| | (b) <i>Ganná</i> CANE. | | | | | | | |
| 51 | Kála ganná ... | 9 | 7 | 24 | 2 | 2½ | 2½ | 2½ |
| 52 | Agaul ... | 6½ | 5½ | 29 | 2½ | 3 | 3 | 2½ |
| 53 | Dikchan ... | 6½ | 5½ | 30 | 2½ | 2½ | 3 | 2 |
| 54 | Ghopará ... | 6½ | 5½ | 22 | 2 | 2½ | 2½ | 1 |
| 55 | Mungá ... | 7½ | 5 | 27 | 2½ | 2½ | 3 | 2 |
| 56 | Tanká ... | 9 | 6½ | 28 | 2½ | 2½ | 2½ | 2 |
| 57 | Katúra ... | 9 | 8 | 26 | 2 | 3 | 3 | 2 |
| 58 | Pansáhi ... | 8½ | 7½ | 27 | 2½ | 3 | 3 | 2 |
| | (c) <i>Paundá</i> CANE. | | | | | | | |
| 59 | Saháranpuri ... | 13 | 8½ | 30 | 4½ | 4½ | 4½ | 3 |
| 60 | Gajri ... | 5 | 4 | 23 | 2½ | 3 | 3 | 2 |
| 61 | Thún ... | ... | ... | ... | ... | ... | ... | ... |
| 62 | Kála paundá ... | ... | ... | ... | ... | ... | ... | ... |
| 63 | Madrási ... | ... | ... | ... | ... | ... | ... | ... |
| 64 | Pooná ... | ... | ... | ... | ... | ... | ... | ... |
| 65 | Bombai ... | 9½ | 8 | 30 | 4½ | 4½ | 4½ | 2½ |
| 66 | Barmi ... | ... | ... | ... | ... | ... | ... | ... |
| 67 | Banáresi ... | ... | ... | ... | ... | ... | ... | ... |

NOTE.—Where columns are blank it should be understood that measurements are not available.

CHAPTER III.

METHODS OF CULTIVATION.

SUGARCANE is grown in these Provinces under three different systems of treatment. In one the land is kept fallow for a whole year following the removal of a spring crop. In the second a winter fallow is allowed after a rain (*kharíf*) or an autumn (*agahni*) crop. In the third the ground is prepared and cane sown immediately after a spring crop has been cleared from the land.

The best crop is naturally expected from the first system, known as *parhel* or *sáir* in the Meerut Division, *pandrá* or *jaunál* in Rohilkhand, *parui* in Oudh, and *ukháó* in the eastern districts.

Cane is grown under this system chiefly in well-irrigated tracts. The next best crop is generally obtained under the second system, known as *khárik*, *bhadrá*, *dotoi*, *urdin*, or *dhankhará*.

This intermediate system is commonly followed everywhere, but especially in canal-irrigated areas. The poorest crop must always be expected from the third system, known as *keraiyá* or *jaunár*, which is, however, seldom adopted owing to the shortness of the time left for preparing the ground.

CULTIVATION OF *ukh* AND *ganná* CANES.

Ploughing.—Under the first system ploughing commences as soon as the rains have set in and is continued till the sowing time. In the second it begins soon after the rain or the autumn crop, as the case may be, has been removed, the land being watered if necessary in order to soften the soil to admit of its being ploughed. This watering is known as *palewá*, *palewát*, or *phataká*.

The number of ploughings varies from 15 to 20 in the west and from 20 to 40 in the east, according to the cultivator's means and the system followed. When, however, cane is grown immediately after the land has been cleared of a spring crop, it is not ploughed more than five times owing to insufficiency of time. After every ploughing the land is levelled with a *patelá*, *saráwan*, *mainrá*, *pátá*, or *hengá* (the wooden flat beam).

Manuring.—The cultivators generally use cattle dung or farmyard manure for the *ukh* and *ganná* canes. The manure is usually applied before sowing and incorporated with the soil by ploughing in. The quantity applied varies from 200 to 300 maunds per acre, the *ganná* canes, as a rule, receiving more than the *ukh*.

Just before planting, if time permits, sheep are folded in eastern districts on the field; or, if there is insufficiency of time, the sheep-folding is done when the plants are about three to six inches high above ground. It is believed among the cultivators that the young shoots nibbled by the sheep tiller freely, which is an additional advantage.

PRESERVATION OF SEED.

In the east canes for seed purposes are left standing in the field. They are cut and stripped of their dry leaves a day or two before sowing, and put in water overnight. They are then chopped up in pieces known as *gánr*, *baínrá*, *génrá*, *páinr*, *páinrá*, or *patáinr*. Each piece is about 15 inches long and contains three to five buds. These cuttings are then used for planting. The practice is, however, totally different in the west, especially in the Rohilkhand and Meerut Divisions. In these tracts the top cuttings, known as *agaundi-ká-bij* or *phanká*, are planted, which consist of a portion of the top green leaves and a few of the upper joints, altogether about 15 inches in length. If the seed is cut without that portion of the top green leaves, it is considered to be defective and liable to degenerate. These cuttings are buried in a corner of the field covered lightly with earth, a layer of dry leaves being placed above and underneath. Every

fourth or fifth day water is sprinkled over them to keep them moist. On the day of planting the cuttings are dug out and removed to the field.

SOWING.

If the moisture in the field is less than is necessary for proper germination of the seed, the land is usually irrigated first and then sown in the following manner. In the east generally three ploughs are used, but in the west only two.

In the east the first plough moves straight parallel to the side of the field, only scratching the soil and leading the way to the following ploughs. It is followed by a second plough having a bundle of grass bound round it or two dung cakes fastened to either side of the "*phāṭ*" (share) in order to widen the furrow. The sower follows this plough and drops down the seed into the furrow, leaving a distance of about one foot from seed to seed. He is followed by a second man, who puts the seed in its proper place if it does not fall lengthwise into the furrow. The third plough or the last follows the second man and covers the seed with earth. The sowing is so regulated that a space of about a foot is left between the furrows actually receiving the seed.

In the west the first plough known as *satārā* goes in the field behind which moves another plough known as *hari* in the same furrow with a wooden mould board attached to it, to broaden and deepen the furrow. The mould board consists of two semicircular pieces of wood called "*par*" fastened on both sides to the wooden portion or body of the plough.

Behind this plough the sower called "*hāthi*" drops the seed lengthwise into the furrows; the seed is put in its proper place by a second man known as *kauwa* following the *hāthi*. Besides the *hāthi* there is a third man with a basket, known as *pallā*, tied round his waist, full of cuttings with which he supplies the *hāthi*.

The first plough in reversing its motion fills the earth into the furrow in which the seed has been dropped. After sowing the land is levelled with the wooden beam.

The time for sowing ranges from the middle of February to the middle of April, the largest area in the country being planted during March.

IRRIGATION, HOEING, AND WEEDING.

The sugarcane field is watered once before sowing and from three to seven times between sowing and harvesting. In a dry year even more waterings are needed. In *khādar* lands the crop requires very few waterings, and sometimes none at all. Four or five days after sowing the first hoeing known as *patanṛ* or *paṇṇā sambhātṇā* is done. After every watering two hoeings are made. When the plants are very young every hoeing is followed by levelling the ground with *patēlā*. After the commencement of rain, or when the plants are about two feet above the ground, the hoed up field is levelled with the feet. This operation is known among the cultivators as "*paintarnā*." The number of times the crop is hoed varies from 7 to 14.

In eastern districts there is a saying with reference to the number of the waterings and hoeings, which runs as follows :—

چار کھاری چودہ کرر
تب دیکھو ہودا کی ادر

“Give four waterings and fourteen hoeings,
“Then look forward to see jarfuls of juice.”

FENCING AND TYING.

To save the crop from the attacks of wild animals the field is not uncommonly either enclosed with some hedge plant, or a mud embankment is made all round. The plants grown as a hedge are *sai* (*Hibiscus cannabifolius*), *arhar* (*Cajanus indica*); and castor (*Ricinus communis*). Should the canes grow very tall, they sometimes fall down partly owing to their own weight and partly to the force of the wind. To keep the canes erect a few stems are tied together.

PARTICULARS OF THE *péri* SYSTEM (RATOONING).

In the west and in parts of the Doab the cultivators grow a sugarcane crop from the roots of the previous year's crop. The first year's crop is known among them as *naulaf* or *babéru*, and the second year's crop is called *péri*.

To propagate the *péri* crop the roots are left undisturbed from the time of first cutting, and the stripped leaves of the first year's crop are burnt in the field before the commencement of the rains.

After the rains have set in and the young shoots begin to sprout, the field is ploughed up, the furrows being from six to nine inches apart. This operation is known among the cultivators as *bidhānā*.

In some districts, instead of ploughing the field it is dug with the hoe (*kudāli* or *kassi*). The quality of *gur* produced from the second year's crop is said to be better than that produced from the first year's crop, but the outturn is invariably lower under similar conditions of fertility of the soil.

We quote below the figures of two crop-cutting experiments we carried out in Kanauj, one with a first year's crop and the other with a *péri* crop, both grown in lands of similar quality :—

| Kind of crop. | Area experi- mented on. | Weight of cane cut and crushed. | Weight of juice expressed. | Weight of <i>gur</i> obtained. | Outturn of <i>gur</i> per acre. | Percentage of— | | |
|-----------------------|----------------------------|---------------------------------------|-------------------------------|-----------------------------------|------------------------------------|-------------------|-------------------------|------------------------|
| | | | | | | Juice in cane. | <i>Gur</i> in juice. | <i>Gur</i> in cane. |
| | Sq. yds. | Mds. s. c. | Mds. s. | Mds. s. c. | Mds. s. c. | | | |
| First year's crop ... | 484 | 21 21 0 | 12 5 | 2 14 8 | 23 25 0 | 56.33 | 19.48 | 10.90 |
| Second „ ... | 134 | 6 15 8 | 3 16 | 0 22 12 | 20 21 12 | 53.23 | 16.73 | 8.90 |

HARVESTING.

Soon after the *Deothān*, a festival observed among the Hindus on the 11th day of *Kātik*, which falls on some day between the beginning and the middle of

November, the cane crop is believed to have attained maturity and is considered fit for crushing. The cultivator, however, does not ordinarily commence cane-crushing until December, after he has completely finished his *rabi* sowing. The cane crushed later on in January and February is, generally speaking, richer in sugar.

- In the eastern districts the crop is cut with the *kudāli* (Figure No. 1); in the western with the spade (*phaṛuā*) (Figure No. 2); but in the Agra Division the cane is generally uprooted by a sharp jerk of the hand, without the use of any implement.

FIG. 1.



FIG. 2.

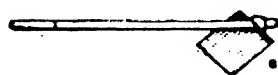


FIG. 3.



Harvesters assemble in the field usually in the morning, and each of them is at liberty to cut as much as he can. He strips the side dry leaves with a sickle known in the western districts as *darānti* (Figure No. 3), (a sharp, crooked, and saw-toothed iron blade having a wooden handle attached to it), and in the eastern with the *hansā*, a sickle having no teeth. The green tops, which are much relished by the cattle, are cut off by the same implement.

The dry leaves are left in the field to be collected and tied into big bundles, which are carried to the boiling shed to be used as fuel for boiling the juice, or else stored for thatching huts or spreading as litter in cattle sheds.

When the stock of canes cut and stripped of their leaves is sufficient to feed the cane-crushing machine for a day, they are tied into bundles and carried in headloads by the reapers themselves or else carted to the mill. Each headload weighs on an average about a maund. The labourers get as wages five canes per head, together with the green tops they have cut, and are also allowed to eat a few canes when they are at work.

METHOD OF CULTIVATION OF *paundā* CANES.

The method of cultivation of *paundā* differs from that of the *ukh* and *gannā* canes in the following respects :—

- (1) The field is dug up one foot deep with spades before planting, with a view to attaining the necessary depth of the seed bed and destroying white ants and other insects injurious to the crop.
- (2) The *paundā* crop is usually sown earlier than the *ukh*, in view of the fact that the sooner the cane comes into the market, the better the price it fetches.
- (3) Seed sets of the *ukh* canes are sown on the flat behind the plough and the field is levelled with *patēlā*, whereas the *paundā* cuttings are dropped into furrows between ridges into which the field has been previously laid out, and are covered over with earth, the furrows being from 24 to 36 inches apart and the distance between the seed cuttings in the furrow being about two inches. The space between

the ridges also serves as a water channel. The field is watered, as a rule, immediately after planting.

(4) Poudrette is generally applied to the *paundá* crop instead of farmyard manure, at the rate of 600 to 800 maunds per acre; or even more. In other words, the quantity of manure is about three times as much as is required for an *ukh* crop.

(5) The first hoeing is done as soon as the land gets sufficiently dry after the second watering. The field is then watered again; subsequently the ridges are split, and the field levelled and divided into irrigation beds.

Hoeings and waterings continue till the advent of the rains. In July or August the plants are earthed up.

The number of waterings varies from 12 to 17 during the period of growth, according to the requirements of the season, and from five to seven hoeings are done altogether. When a crop shows a tendency to grow luxuriantly, the plants are tied together to prevent their falling over.

THE COST OF CULTIVATION.

The following is a statement showing in detail the various items of the cost of cultivation of sugarcane under the "*khárik*" system, which is most commonly followed in the various cane-growing tracts of these Provinces. The calculations are based upon the assumption that all operations are paid for in cash:—

Statement showing the cost of cultivation of sugarcane per acre in different tracts of the United Provinces.

| Name of tract. | Ploughing. | | Seed. | Cost of sowing. | Harrow and weeding. | | Irrigation. | | Manure. | Rent. | Total. |
|---|------------|-----------|-----------|-----------------|---------------------|-----------|-------------------|-----------|-----------|-----------|-----------|
| | Number. | Cost. | | | Number. | Cost. | Sources of water. | Cost. | | | |
| | | Rs. a. p. | Rs. a. p. | Rs. a. p. | | Rs. a. p. | | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. |
| Meerut Division, except Dehra Dūn. | 14 | 10 8 0 | 8 0 0 | 2 8 0 | 8 | 10 0 0 | Canal | 18 0 0 | 5 0 0 | 12 0 0 | 65 0 0 |
| Agra Division | 18 | 9 0 0 | 10 0 0 | 2 6 0 | 6 | 13 8 0 | Well and canal. | 20 14 0 | 3 0 0 | 8 12 0 | 72 8 0 |
| Rohilkhand Division | 15 | 15 0 0 | 12 0 0 | 2 4 0 | 5 | 11 4 0 | Do. | 15 0 0 | 9 0 0 | 13 8 0 | 81 0 0 |
| Allahabad Division, except Bundelkhand. | 15 | 15 0 0 | 11 0 0 | 2 8 0 | 4 | 5 0 0 | Well | 16 2 0 | 6 0 0 | 12 0 0 | 67 8 0 |
| Bundelkhand | 9 | 6 12 0 | 12 0 0 | 2 8 0 | 5 | 11 4 0 | Do. | 20 0 0 | 8 0 0 | 7 8 0 | 63 0 0 |
| Benares Division | 16 | 8 0 0 | 10 0 0 | 3 0 0 | 11 | 9 4 0 | Do. | 20 0 0 | 6 12 0 | 10 0 0 | 67 0 0 |
| Gorakhpur Division | 20 | 15 0 0 | 9 6 0 | 2 4 0 | 14 | 15 13 0 | Do. | 12 13 0 | 7 4 0 | 12 4 0 | 74 12 0 |
| Lucknow Division | 15 | 15 0 0 | 9 0 0 | 3 0 0 | 10 | 12 0 0 | Well | 18 0 0 | 10 0 0 | 13 0 0 | 80 0 0 |
| Fyzabad Division | 17 | 17 0 0 | 9 0 0 | 3 0 0 | 10 | 6 0 0 | Do. | 15 0 0 | 9 0 0 | 13 0 0 | 72 0 0 |

The following remarks explain the various heads of expenditure enumerated in the statement :—

Ploughing an acre of ground takes from one to two days, according to the size and strength of bullocks, the efficiency of the plough, the texture of the soil, and the degree of moisture in it, the first two or three ploughings usually occupying more time than those which follow. Thus in Meerut, where abundance of canal water is easily available for *palérá*, where the soil is fairly light and bullocks strong, an acre of land can be conveniently ploughed up in a day. In Agra, where the soil is lighter still, though irrigation is not always an equally easy affair, the same period is sufficient to plough an acre. In eastern districts, such as Benares, Fyzabad, Sultánpur, and Bartábgarh, where bullocks are weak and ploughs small, two days are commonly devoted to an acre. In the western districts the hire of bullocks varies from eight to ten annas; in the east it ranges from six to eight annas, the wages of the ploughman being the same all over the country, *viz.*, two annas a day. The cost of ploughing shown under each tract in the statement has been calculated with due regard to these different conditions.

Cost of seed.—The cultivator generally uses his own seed for sowing. Occasionally, however, it is purchased.

The cost varies in some measure with the kind to be grown, *e.g.*, in Sultánpur the cost of *kusár* seed is higher than that of *hárá*. In Basti the mango seed is dearer than *munchá* or *hárá*. In Cawnpore *baraukhá* is cheaper than *matná*. It also varies with the stage of the season, the seed getting usually dearer as the sowing season advances.

On the whole, however, the cost of the seed may be taken as fairly uniform all over the places where whole canes are cut up for planting. In the western districts, where tops alone are planted, the cost is comparatively low, as they cannot be profitably put to the purpose of *gur*-making, and are therefore obviously of little value as compared with whole canes, except for seed purposes. The practice of sowing the tops is one which might with advantage be adopted in other cane-growing tracts.

From four to five thousand canes are required to plant an acre, and their cost varies from Rs. 7 to Rs. 12.

Cost of sowing.—The cost of sowing varies with the number of ploughs used and the labourers engaged. From 8 to 12 labourers are put in the field to sow an acre of land, and are paid from $1\frac{1}{2}$ to 2 annas per head daily.

Hoeing.—The number of hoeings varies from four to fourteen in different tracts according to local custom. In some places each watering is followed by one hoeing and in others by two, while in some neither of these practices is rigidly followed, the number depending upon the leisure and means of the cultivator, but being in no case less than the number of waterings. The number of hoeings shown in the statement opposite each tract is the average. Twelve to eighteen labourers hoe an acre of land in a day, costing Re. 1-2-0 to Rs. 2-4-0, according as the implement used is the *kudáli*, *kassi*, or *khurpi*. The number of

labourers also depends upon the amount of moisture in the ground. In some localities they are paid in cash, in others in grain, and in some places partly in grain and partly in cash. The wages in the statement have been calculated according to the different systems of payment in vogue in different places.

Irrigation.—In canal-irrigated tracts the cost of irrigation is generally low as compared with the eastern districts, where well or tank irrigation is resorted to; but the number of waterings in the former is comparatively large on account of the greater opportunities the cultivator has of getting water.

In Bundelkhand and the Eastern Doab watering is particularly expensive, as *kachchá* wells have to be dug especially for cane fields, each well involving an expenditure of about Rs. 3. Ten to twelve labourers may be sufficient to irrigate an acre of land in two days from tank or canal, whereas thirteen to fourteen labourers or two pairs of bullocks and four labourers may be required to water the same area in three days from a well respectively by means of *gharrá* or the common single *mot*. They are paid according to local custom under different systems described under hoeing. In terms of cash the daily wages of labourers employed for irrigation may be taken to be two annas a head. The cost of tank irrigation differs little from that of canal, the number of labourers in each case depending upon the depth of water and the number of baling stations where the water is lifted up.

Rent.—One and a half year's rent has been taken into account in each tract, according to the average rates reported by the *kanúngos*.

Manuring.—As regards manuring, no special remarks seem called for. The cultivators apply as much manure as they can get. The cost of manure shown opposite each tract has been calculated with reference to the estimated quantity generally used and the price of manure prevalent in it.

In the above statement we have not included a very important item of expenditure, *viz.*, cost of making *gur* or *ráb*. This varies from Rs. 30 to Rs. 40 in the different tracts, according to the quality of the crop, the mill used, and other conditions. The average cost of the manufacture of *gur* or *ráb* from an acre may safely be put down at Rs. 36, a detail of which will be found in the chapter dealing with the manufacture of raw sugars.

The cultivator's profit.—To determine the cultivator's profit on the above data, we may take the case of Meerut as an example. The cost of cultivation in this tract amounts to Rs. 66. Adding to this Rs. 36, the cost of manufacture of *gur*, the total, Rs. 102, represents the aggregate cost of producing thirty-five maunds of *gur*, which is the average outturn of the Meerut tract. This leaves the cultivator the nominal net profit of Rs. 3 per acre.

Profits in other tracts may be calculated similarly.

It must, however, be borne in mind that, as a matter of fact, there are few items of expenditure except the rent, canal due, and hire of iron mill which the cultivators actually pay in cash. Ordinarily, all or the greater part of the labour is performed by the cultivator and his family with his own bullocks,

or partly by himself and his family, and partly by his friends in the village for whom he works in return. Therefore a considerable portion of the cost of labour shown in the above statement substantially represents his own remuneration and profits. Sometimes, however, a little hired labour is indispensable. The less outside labour a cultivator has to employ, the greater is his profit.

Under such circumstances it is obviously impossible to gauge with precision the actual profits of the cultivator in the different parts of the country; and the only conclusion that can be drawn is that cane cannot be profitably cultivated except by those persons who can get most of the necessary labour without payment or who have exceptional advantage in other ways. On the other hand, the crop is the great resource of the skillful and industrious cultivator.

The following is an estimate of the cost per acre of the cultivation of *paundâ* in the neighbourhood of Cawnpore:—

| | Rs. | a. | p. |
|-----------------------------------|-----|----|----|
| Ploughing 12 times | 9 | 0 | 0 |
| Seed | 45 | 0 | 0 |
| Sowing | 6 | 0 | 0 |
| Hoeing and earthing up the plants | 24 | 8 | 0 |
| Watering 12 times | 36 | 0 | 0 |
| Manure | 25 | 0 | 0 |
| Rent, one and a half year's | 12 | 0 | 0 |
| Total | 157 | 8 | 0 |

A standing crop of this sort should sell for Rs. 180 to Rs. 200.

CHAPTER IV.

DISEASES AND ENEMIES.

THIS subject may be conveniently treated under three heads, *viz.*, (1) insect pests, (2) fungus pests, and (3) other enemies and injuries.

(1) *Insect pests.*

(a) One of the most destructive of these is the white ant commonly known as "*dimak*," "*diupk*," "*deupkâ*," and "*tanrâ*." It is one of the well known wingless* worms of the *pseudo-neuroptera* family belonging to the genus *termite*, and is closely allied to, or identical with, the species *termes taprobanes* (Walker).

Among the conditions which specially favour the multiplicity of these insects in a cane field, the most common is the application of imperfectly fermented cattle dung. They are more frequently met with in elevated than in lowlying fields liable to floods, and attack chiefly the softer kinds of cane, which yield more readily to the force of their mandibles. They appear in large numbers when the soil is in a semi-parched state, attacking the crop chiefly in the stage of germination and to a smaller extent soon after germination. The cuttings are eaten through horizontally, and the process of germination is stopped. The

* Some are winged during a portion of their existence.

sprouts dry up. The young plant attacked after germination is eaten at the root and dies quickly. Sometimes a whole field is overrun by these marauders, and the crop is very seriously damaged if copious irrigation is not resorted to. They seldom attack a crop after the setting in of the monsoon rains, and it is therefore of great importance to the cultivator to adopt preventive measures during the hot weather, so as to minimize the chances of an attack and the extent of injury in the event of an attack. The only preventive measures adopted are the following:—(1) The cuttings are steeped in a solution of pounded leaves of *rusā* (*Adhatoda vasica*), or (2) mustard cake, or (3) a solution of *usafætida* and common salt. The first two practices are confined to South Oudh. Roots of *kodon* (*Paspalum scrobiculatum*) are also supposed to keep off white ants. If a *kodon* crop be grown previously on the field, the succeeding crop of sugarcane will not, it is stated, be affected—not seriously at any rate. In the Bombay Presidency castor cake used as manure is believed to keep white ants away. It may here be mentioned that Wray records the fact that the antipathy of white ants for petroleum is so great that tops or cuttings soaked for a few minutes in water tainted with petroleum will never be attacked by them. He says that “where the soil is impregnated with petroleum, white ants are unknown.” After the crop has been attacked the progress of white ants can always be more or less effectively checked by heavy watering. Flowers of the *dhāk* tree (*Butea frondosa*), or of *senbal* (the silk cotton tree), or the straw of *alsi* (*Linum usitatissimum*), or bits of the stem of *senhupr*, or mixtures of two or more of these things, are sometimes placed at the head of the channel through which the irrigation water passes into the field, so that it may dissolve the soluble substances present in those materials and carry them into the field, these substances being supposed to be injurious to the white ants.

Sometimes *dhāk* flowers are spread over the field like manure, and water applied.

A common practice is to put dung cakes in *hāndis* (earthen pots) and sink them into the ground in the corners of the fields. The cakes attract the white ants, and when the pots are swarming with the insects, the latter are removed and destroyed.

Constant deep hoeing is perhaps one of the best measures for removal of the pest.

A cane field infested with white ants should, after removal of the crop, be tilled deep and the furrow slices well exposed.

(b) *The sugarcane borer*.—This is a common pest, and its ravages are often very destructive. It makes its appearance at two different stages of growth: first in April and May, when the crop is young; and then towards the latter part of the rains, when the plants have grown to a fairly good height. Specimens of the caterpillar of this moth collected in both stages from affected crops were identified at the Calcutta Museum as *Diatraea saccharalis* (Cotes), an insect of the order *Microlepidoptera*. The cultivators in these Provinces give different names to the insect or the disease it causes in the two different stages. In

the earlier stage it is known as *salái* in Meerut; *makoiyá* in Bijnor and Agra; *obrá* in Farrukhabad, Fatehpur, and Gházipur; *sundi* in Aligarh, Bareilly, Pilibhít, and Naini Tál; *phunkahá* in Basti; *katwá* in Mirzápúr; *reonthá* in Cawnpore; and *pihká* in most of the remaining districts.

The account of the life history of the insect given in the footnote* below is reproduced from Mr. Cotes' *Indian Museum Notes*, Volume I. The *larva* burrows into the main stalk of the young plant, thereby setting up putrefaction. The stalk dries up and can be easily pulled out by the hand from its covering of leaves, which also wither up. The lower part of the stalk looks completely rotten and emits a most disagreeable smell. The caterpillar is not always found in the stalk as it probably makes its way to another plant before the indications of an attack are sufficiently clear, but the hole which it has made in the stem is always perceptible. In some of the holes the grub living or dead may, however, be found. We have almost invariably seen a kind of ant of the genus *Dorylus*, identified in Calcutta as *Dorylus aromensis*, in large numbers on the leaves of the affected plant and inside the rotten stalk. An ordinary observer is very liable to be led to the belief that these ants are the cause of the damage; but it is not so. They are not obnoxious to plant life, and live entirely on animal food. Probably they go to the damaged cane, hunting after the caterpillar which has really caused the injury, and the offensive odour just mentioned may possibly be due in part to the decomposition of bodies of the grubs destroyed by them. The damage done by the insect at this stage of the growth is sometimes considerable. The crop of 1888 is said to have been damaged to the extent of 25 per cent. in the neighbourhood of the Cawnpore Farm. With moderate irrigation followed by hand hoeing, which is the only remedy employed, or with the advent of monsoon rain, the caterpillars disappear. The affected plants throw off fresh shoots, which, however, seldom grow into canes of the normal size. If the rainfall is

* The life history of the insect has not yet been fully studied in India, but what has been observed agrees so closely with the observations made on the corresponding sugarcane pests of other parts of the world that we may safely infer the rest, and the following account, therefore, is taken from Dr. Riley's paper on the pest in America, where, however, the insect is likely to take rather longer to pass through the various stages of its existence than in the warm climate of India.

The parent moth lays her eggs upon the leaves of the young cane near the axils, and the young borer, hatching in the course of a few days, penetrates the stalk at or near the joint, and commences to tunnel through the soft pith. The eggs are flat and circular, one-twenty-fifth of an inch in diameter, and are white when first deposited, turning yellow as they approach the hatching point. The growth of the borer worm must be very rapid, less than thirty days being probably occupied in the larval state. The borers are quite active, and occasionally leave their burrows and crawl about upon the outside of the stalk, seeking another place to enter. The full grown borer is about an inch long, rather slender, nearly cylindrical, and cream white in general colour, but speckled with black spots with a yellow head and black mouth parts. Upon attaining its full size, it bores to the outside of the cane and makes a large, round hole for its future exit—a hole which is usually at least one-fifth of an inch in diameter. It then retires into its burrow and transforms, a short distance from the opening, into a slender brown *pupa*, three-quarters of an inch long. The *pupa* state lasts but a few days, and then the moth makes its exit. The moth has a spread of wings of about an inch and a quarter, and is of a light, greyish brown colour. With the female moth the hind wings are of nearly the same colour with the fore wings; but with the male the former are silvery white. There are several broods in the course of the season, and the insects hibernate almost exclusively in the larval or "worm" state. During the winter they are to be found most abundantly in the seed cane, but also in the discarded tops, and to a slighter extent in the stubble.

abundant at the commencement and is followed by several days of dry weather, the stagnation of water in the field, and the subsequent drying up of the land, materially interfere with the development of new shoots, and the damage in that case is serious. Monsoon rains prove beneficial to the affected crop only when judicious watering and hoeing have been carried on throughout the hot season, and the young shoots in the affected stools are sufficiently advanced to get full benefit of the rain.

Messrs. Lock, Wigfler, and Harland suggest as a means of checking the ravages of the "borer" to plant a hedge of *arhar* (*Cajanus indicus*) around each field, and to grow *sém* (the bonavist bean or *Dolichos lablab*) and *arhar* on all fallow fields intended for sugarcane, ploughing in this latter growth as a green manure.

These plants attract *Ichneumon* flies (which are natural enemies of the cane borer) in such numbers that the fields may be completely freed from the destructive vermin.

They also recommend abundant application of lime, which will generally be found beneficial in destroying the insects, besides being useful as a manure.

A widely adopted plan in some of the foreign cane-producing countries is to allow the first shoots that spring from the planted cane cuttings to grow for about three months, by which time the grubs will have congregated on them. The shoots are then cut close to the ground, piled in heaps, and buried. The second crop of shoots soon appears, and the skins of these latter are said to be much tougher, and better able to resist the attacks of the grubs which may have escaped the burning. This plan is often supplemented by sending labourers to destroy all the caterpillar they can find on the second growth of canes.

To us it seems advisable that, with a view to minimizing the injury, the affected plants should be cut close to the ground as soon as the symptoms of an attack are apparent and the leaves, &c., collected and burnt.

The second period during which the caterpillar makes its appearance generally begins in August or September, and it is popularly believed that the south-westerly wind, accompanied by continuous drizzling, favours the appearance and a rapid growth of the grubs. At this stage the larvæ tunnel through the first three or four joints at the top, the growth of the cane towards the top is stopped, and the cane throws off young shoots from the upper joints, the attacked cane being known as *mathmuá*, *kanphará*, or *badhiá* as distinguished from *musgandá*, the cane which has escaped an attack. The quality of the juice in the cane is slightly injured, but beyond this and an arrest of the normal growth, little harm is done. The ravages of the insect usually continue till late in the crushing season, and living caterpillars are found at the top even when the cane is being cut for replanting. At this stage of the attack the caterpillar is called *kansuá* in Meerut, *ghundi* in Saháranpur, *ár* and *pharká* in Muzaffarnagar, *margel* and *medá* in Saháranpur, *ghirái* in Agra, *girár* in Aligarh, Moradabad, Sitapur, and Lucknow, *tiktá* and *kanwá* in parts of the Eastern Doáb, *khairá* in Basti, Pilibhít,

Bahraich, and Fyzabad, *kungá* in South Oudh, *hárá* in Gházipur, *sainun* in Gonda, *kinni* in Gorakhpur, and *dholá* in Azamgarh. There are possibly other local names of which we are not aware. The cultivators apply no remedies and indeed know of none. The following notes borrowed from Lock, Wigner, and Harland regarding the preventive measures that might be adopted are worthy of special attention :—

“Hidden in the cane tops are the *chrysalides* of the insects, which in due course are transformed into moths and butterflies, whose eggs supply a new swarm of caterpillars and grubs, and thus the evil is constantly maintained.”

Obviously, therefore, great good may be gained by ridding the cane tops of all vermin, whether in a perfect or imperfect state, before planting. A very simple plan is to soak the cuttings for twenty-four hours in water which is sufficiently hot to destroy the larvæ which may be infesting it, without being hot enough to injure the germinating powers of the plant. A more effective remedy is the use of antiseptic preparations, as they attack parasitic growths which would be unaffected by mere warm water. Dr. Bancroft, in Queensland, has published exact directions for a treatment which he has adopted with complete success : it is as follows :—

“(1) Clean the joints of the cuttings entirely from trash (leaves) as carefully as possible; (2) immerse the cuttings for twenty-four hours in a mixture of 1lb. of carbolic acid to 50 gallons of water, the water being heated to a degree that the hand can bear; (3) immerse the cuttings for a few minutes in milk of lime, made by mixing 2lbs. of slaked lime with a gallon of water; (4) spread the cuttings out to dry in the sun, and turn occasionally for a day before planting.”

The following suggestions from other writers on the subject are reproduced from *Indian Museum Notes* by Mr. Cotes :—

Guilting recommends that all the dry and useless leaves, under which, he says, the moth lays its eggs, should be stripped off : he claims that this treatment has been found effective in removing the pest.

Porter quotes the practice of “introducing a pinch of quicklime into the heart of the young cane” for the destruction of the pest.

Westwood notices that in Jamaica, in 1841, the ravages of the borer were to a great extent checked by allowing the refuse to accumulate upon the ground, and burning the insects there, the old roots subsequently throwing up more vigorous shoots.

Miss Ormerod, in writing of the pest in British Guiana about the year 1879, quotes the practice of cutting back the cane below the surface of the ground, covering the plant with mould, and adding a handful of lime. The cutting out of the affected canes was tried on one estate, over 246 acres, the result being considered satisfactory. In this case the canes cut out were put through the mill, and sufficient rum and megass obtained from them to pay expenses. Miss Ormerod also quotes the practice of steeping the cane for forty-eight hours in water before

planting it—a treatment which was thought on one plantation, where it was tried, to destroy the hibernating larvæ without injury to the cane. It appears, from the enquiries instituted in British Guiana, that it is a mistake to burn the refuse sugarcane on the fields themselves, as this destroys the ants, which, when unmolested, rendered valuable assistance in keeping down the pest. The plan, therefore, approved was to burn the refuse cane after collecting it in heaps outside the fields.

Dr. Riley recommends burning all tops during the winter so as to destroy the larvæ which hibernate in them; selecting seed cane from the least infested portion of the plantation and laying it down in furrows during the winter, covered with earth as deeply as may be found possible without inducing decay, and only uncovering it as it is wanted in the spring for planting out, thus preventing the egress of moths from the larvæ which have hibernated in the seed cane.

Roth writes that “he has kept the pest under control in Queensland by sending boys with sharp pocket knives along the rows of cane. The boys spotted the dead or dying shoots and cut them off as close as possible to the parent cutting. They then opened the shoot and destroyed the fat grub. In some cases, however, the grub had migrated to a fresh shoot which as yet did not show any sign of decay, and thus escaped.” Roth adds that “while dirty fields were being destroyed wholesale by the grub, clean fields were not infected to any such extent.”

(c) *Kāri*.—We have seen this pest do much damage in Azamgarh, and its occurrence has also been reported from Partabgarh, Allahabad, Mirzapur, and Ghazipur. The first indications of the attack are noticed in the beginning of the rains, when dark spots make their appearance on the surface of the leaves; hence the name *kāri* (black). An insect known as *gandhūt*, which is dark in colour and has two strong mandibles, afterwards makes its appearance and lays eggs on the surface of the shoots in different parts below the sheath which covers the stem. The eggs are of a bright red colour. They hatch, and the young creatures grow quickly. They reproduce themselves, and multiply with great rapidity. The insects eat into the stem, sucking the juice and causing a serious deterioration in its quality. The colour of the pith becomes dirty, and the cane gets hollow inside. The *gur* manufactured from the affected canes does not solidify, and the outturn is exceedingly poor in quantity. The pest generally attacks only the softer races of *ukh*, chiefly the *reorā*; and a cane which has been previously attacked by the borer yields more readily to an attack of this pest. White and dark spots also appear on the lower surface of the leaf blades. The insect rubbed between the fingers smells like a common bug. A specimen of the insect has been identified in Calcutta as a form of bug belonging to the family *lygeidae*. The cuttings from the affected canes do not germinate well. No remedy is known, but probably the best means of getting rid of the insects will be to cut the crop and burn the leaves and stems so as to clean the field of

these destructive insects. Insecticide spray applications may also be employed with advantage. The following may be a good formula :—

| | | | | | |
|--------------|-----|-----|-----|-----|-------------|
| Kerosine oil | ... | ... | ... | ... | 2 gallons. |
| Common soap | ... | ... | ... | ... | ½ lb. |
| Water | ... | ... | ... | ... | 10 gallons. |

Dissolve the soap in one gallon of water, gradually beat in the kerosine oil, then gradually add the rest of the water.

(d) *The grasshopper*—Known in different parts of the country as *totá*, *phangá*, *charká*, *bot*, and *boti*, is a well known insect of green colour identified by the Museum experts in Calcutta as *Hieroglyphus furcifer* Sauss. It generally appears in very large numbers about the middle of the rainy season, when there is a long break after a heavy rainfall and defoliates the cane, the flight of insects attacking one field after another and causing great damage. The vigour of the plants is more or less exhausted and their growth stunted. In 1898 they did much mischief in parts of the Sháhjahánpur and Kheri districts. A similar insect, known as *ankhphuttá* in Cawnpore and identified as *Pacilocera hieroglyphica* Klug, attacks the cane crop similarly.

Certain *aphides* injure the cane by feeding on the juices of the plant, and their presence is characterized by the appearance of a viscous matter on the stem and the leaves. The injury is generally known as *chepá* (anything which sticks) or *lakhá*. When the insects appear, insecticide spray applications, such as a solution of soap or kerosine emulsion, may be employed with good results.

A red insect, called *ratel*, is reported from Jhánsi to attack the cane crop in the rains: further particulars are not known. Among other insects attacking sugarcane in India, Mr. Cotes enumerates—

- (1) *Xyleborus perforans* (Wollast), a little brown beetle.
- (2) *Mancipium nepalensis* (Grey), a white butterfly.
- (3) *Achaea melicerte* (Drury), one of the *noctues*.
- (4) *Dragana pansalis* (Walker), one of the *deltoides*.

We have not seen or heard of these in the course of our investigations; but we mention them here as known to entomological experts as injurious to sugarcane.

(2) *Fungus pests.*

(a) *Dark smut*.—Among the fungi a very common pest is the one known as *kandwá* or *karanjwá*, belonging apparently to that species of *ustilago* which causes the smut in ordinary cereals. It generally attacks the red canes which are in the habit of flowering, *chan* and *baraukhá* being most liable to it in Etáwah and Mainpuri. The chief seat of the disease is the flowering *rachis*, which becomes dark in colour. In some cases the juice is so seriously damaged after the attack that even cattle refuse to eat the affected canes. The *gur* made from such juice does not solidify. The only remedy that suggests itself is the removal and burning of all the affected shoots.

(b) *Rind fungus, red patch, or red smut*.—This disease is caused by the fungus *Trichosphaeria sacchari*, and is known in these Provinces under different

local names, viz., *lawáhi*, *lauhá*, *ukhrá*, *ukhtá*, *ugthá*, *umsá*, *agiá*, *sukhá*, *sukhandi*, *ratár*, *ramtiddá*, and *kántar*.

The history of the disease is obscure. No one seems to know how it originated, and the conditions under which it makes its appearance are but imperfectly understood.

So far only the *ganná* canes named on the margin appear to have been affected

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|--|--|
| <p>(1) The "<i>gagaul</i>," "<i>merthi</i>," or "<i>Bareilly</i>" cane of Meerut and Muzaffarnagar.</p> <p>(2) The <i>agaul</i> or <i>agraul</i> cane of Bareilly, Moradabad, and Pilibhit.</p> <p>(3) The <i>dikhan</i> of Sháhjahánpur and Hardol.</p> <p>(4) The <i>barankhá</i> of Azamgarh (which is totally different from the <i>barankhá</i> of the Doáb and the Fyzabad Division).</p> <p>(5) The <i>pansáhi</i> of Gorakhpur.</p> <p>(6) The <i>katárá</i> of Oudh and the Central and Eastern Doáb.</p> | <p>ed by the rind fungus (<i>Trichosphaeria sacchari</i>), the other kinds of cane having fortunately shown themselves to be practically unsusceptible to an attack of the disease. The disease is usually attended with disastrous consequences, which are naturally more keenly felt and dreaded in the <i>katárá</i>-growing centres than in other parts of the country where the cultivation of <i>ganná</i> races of cane is limited. No definite information is available as to how long the disease has been in</p> |
|--|--|

existence in the United Provinces; but from the evidence collected in Meerut and parts of Rohilkhand it appears that a quarter of a century ago it was unknown, or, at any rate, existed in a form not severe enough to attract serious attention. About 45 years ago the *agaul* cane was imported for the first time into Meerut from Bareilly and acclimatized at Gagaul, a village within a short distance of the city of Meerut. The local name "Gagaul" or "Bareilly" for the *agaul* cane owes its origin to this circumstance. From village Gagaul the seed found its passage into Muzaffarnagar, where the said cane soon acquired popularity. For a number of years this cane did so remarkably well in Meerut and Muzaffarnagar that the local forms of canes were left in the background and the cultivation of the Gagaul extended beyond all expectation; but in the famine year 1877-78, the crop in parts of the Meerut district was so seriously damaged by the rind fungus as to have caused great distress among the cultivators. It is stated independently of this fact that the disease made its first appearance in Pilibhit in the same year. Since then it has occurred in a mild or a severe form in almost all cane-growing tracts. During the past 10 or 12 years it has caused such havoc in Meerut, Rohilkhand, and Gorakhpur that the cultivation of the forms of cane liable to the disease has gradually fallen off year after year, and they have been replaced by the different local forms of *ukh* cane, whose resisting power is fully relied on. The *ganná* canes are, however, generally speaking, so superior to the *ukh* canes in respect of the yield of sugar that a decline in the cultivation of the former, owing to their well known susceptibility to the disease, cannot but be looked upon as a matter for regret. Nor can it be regarded as an inconsiderable loss to the sugar industry of the country. The disease generally makes its appearance towards the end of the rainy season, ordinarily in September, and always during the period of growth; never after the growth is completed. Thus if a crop escapes the attack till January, it is never attacked afterwards. The

first noticeable symptom of an attack is a change of colour in the leaves from a dark green into a pale green, which afterwards becomes lighter as the disease acquires intensity. The next thing that happens is a change in the colour of the rind of the individual internodes mainly affected, which becomes tinged with yellow, the pith inside becoming pale at the same time. The juice loses its flavour and becomes disagreeable to the taste, besides giving off a somewhat unpleasant odour. Later on red dots or spots make their appearance in the pith of the affected part and rapidly increase in size and number. Subsequently the affected internodes shrivel up, the juice totally disappears, the pith becomes spongy, and a black powder is formed in the inner cavity of the internodes. Few canes are, however, completely destroyed in this manner. Ordinarily only a few internodes are severely damaged. These may be sometimes at the top, sometimes at the bottom, and occasionally even in the middle of the cane. So one may find a cane in which only the top part has been destroyed and the rest is only slightly diseased, or one in which only the bottom or the middle portion is seriously injured, showing that the fungus does not, as a rule, damage any particular part of the cane more especially than the other. But when a cane is once attacked, although only a few internodes may shrivel up, yet the remaining internodes (which do not look diseased) are all bound to be affected, and most of them will show on dissection a number of red or dark red spots within a dirty pith. The greater the number of these spots, the more unpleasant the juice is to the taste, and the less will be the amount of sugar in it. In some internodes, however, there may be no characteristic spots or abnormal colour of the pith visible to the naked eye. Internodes which are only slightly affected generally throw off new shoots from their buds or "eyes." All the canes in a clump are seldom affected, if ever—some almost always escaping the disease. When *gannā* canes are sown mixed with *ukh* canes in the same field, the attack of the disease is usually confined to the former, the latter remaining free.

The crop in a poor field is generally more liable to an attack than in one which is in a high agricultural condition.

The character of the season and the amount of rainfall seem to have little influence on the disease, though it is stated that perhaps a dry year is more favourable than a wet year.

The cultivators do not understand the cause of the disease and look upon it as a sort of plague for vegetable life, which they attribute to the divine displeasure. They are, however, aware that if cuttings from a diseased cane be planted, the crop obtained is sure to get the disease. No effective remedy is known. Irrigation is not uncommonly tried with indifferent results, the idea being that the disease might be due to dryness in the soil; but we have seen instances in which a field with sufficient moisture in it was severely injured. Consequently, when a cultivator's crop is ruined once, he gives up the cultivation of that kind of cane and takes to some other (resistant) kind. The only precaution taken in the matter of seed is that the internodes in which the existence of the red

spots is particularly marked are picked out of the seed cuttings and thrown away, while those in which the spots are not visible are used for planting. The leaves of the affected crop are left in the field to rot and get incorporated with the soil in the natural course, and the roots are not dug out or burnt. These circumstances undoubtedly lead to a continuance of the disease in the village in which it once finds its way.

The only remedy suggested is the total destruction by fire of any crop found to be thus diseased, and the introduction of other kinds of cane.

(3) *Other enemies and injuries.*

(a) A vegetable or root parasite, called *Striga lutea*, sometimes grows in abundance in cane fields, and is reported to be known in Gonda as *shahdeigā*. Its fibrous roots entwine round the roots of the sugarcane and check the growth of the latter. The cane crop is practically ruined. No effective remedy is known. Even constant weeding fails to save the crop. The parasite belongs to the natural order *scrophulariaceae* allied to the broom-rape family, and when once it has established itself in a field it is very difficult to eradicate it. Cultivators do not, as a rule, grow cane in a field once infested with the parasite.

(b) *Bigānā* or *bigājānā* is a term used to express the abnormal growth characterized by the springing of young shoots from the various joints of the cane, as a result of defective cultivation, excessive manuring, and immoderate irrigation, but without the influence of any known pest. When this happens, the growth of the stem is stunted and the juice rendered poor in sugar.

(c) Cane grown on low lands suffers seriously from floods in the rains, which reduce the most promising crops to a mere snipe cover.

(d) Severe frosts cause considerable damage sometimes in the western districts.

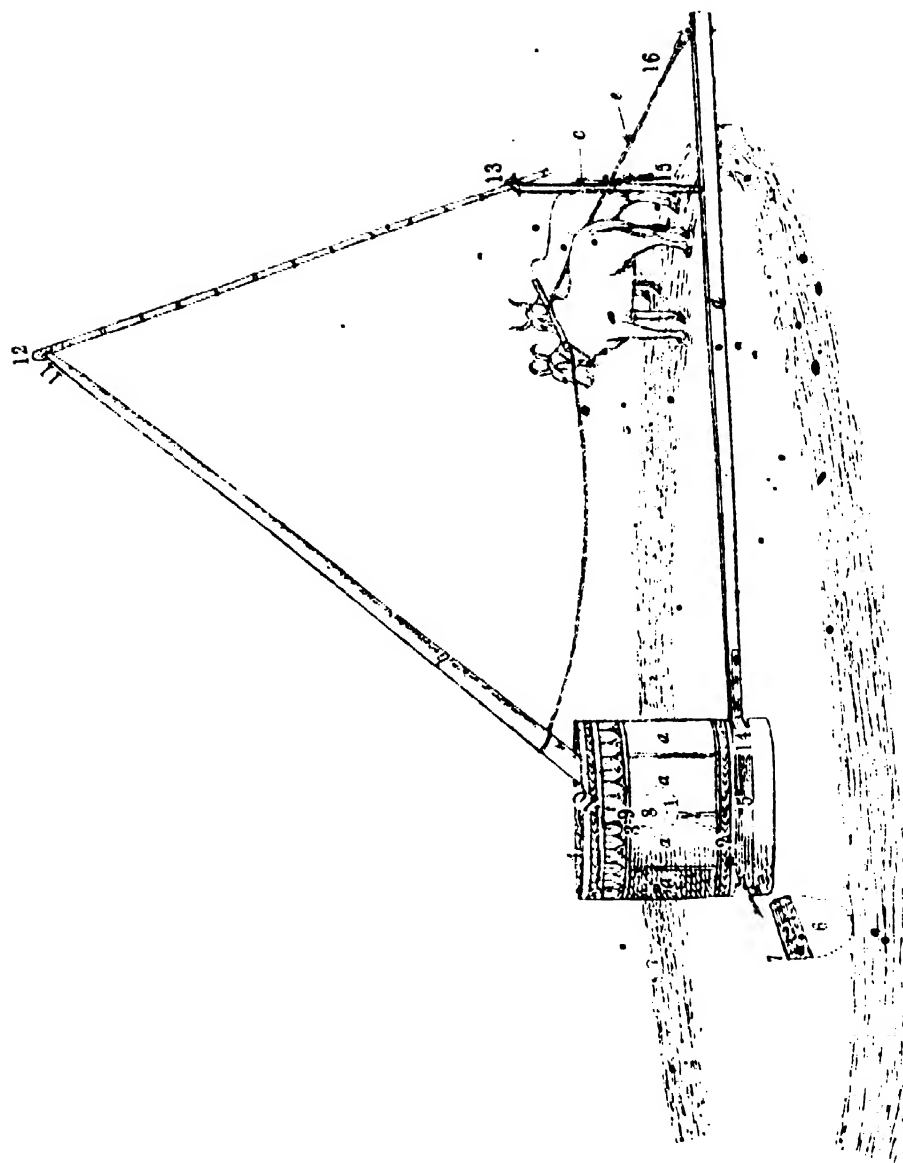
(e) Among wild animals, jackals, wild boars, and rats are the worst enemies. The first two are scared away by various contrivances, and the latter caught in traps or killed by other means.

CHAPTER V.

THE CANE-CRUSHING MILLS, AND THEIR USE FOR EXTRACTION OF THE JUICE.

THE extraction of juice from the cane is effected in these Provinces either by bruising small pieces of canes in a mill constructed like a large pestle and mortar known as *desi kolhu* (country mill) or by crushing whole canes between the revolving rollers of an iron mill (*peck* or *lohia kolhu*). The former process has been in use in these Provinces from the earliest periods. It is stated that in ancient times mills used to be made by cutting down standing trees about two feet above the ground and utilizing the trunk as a pestle and the root as a mortar. Such trees were, however, not available at all times and places. Later on the mortar was therefore made of stone. The most typical of the country presses are—

- (1) the stone mill used in the eastern districts;



THE STONE MILL USED IN THE EASTERN DISTRICTS.

(2) the wooden mill of Oudh and the Eastern Doáb ; and

(3) the Gorakhpur wooden mill.

During the past quarter of a century an iron mill (the Belicá), brought out by certain landlords of Beheá, has gradually replaced the country mills in general to a very considerable extent ; and another, known as the Náhan, has also been gaining ground, especially in the western tracts.

No improvement in agricultural machinery has, it may be remarked, gained so much favour with the common cultivator and with such remarkable rapidity as the iron mills, and this fact alone is the best practical proof of their general superiority over all forms of old-fashioned contrivances for crushing canes.

In the following pages we shall give a brief description of the various mills in common use, and discuss their working capacity :—

(1) *The stone mill of the eastern districts (Illustration I).*

Before the introduction of the two-roller Beheá mill, the stone mill was held in high esteem and was largely used by the well-to-do cultivators. Now its use is confined to districts where stone can be bought or imported at a reasonable cost, *e.g.*, Mirzapur, Benares, Jaunpur, Azamgarh, &c. In these districts stone mortars sunk into the ground have existed for centuries ; and as the cultivator finds no other use for them, he does not care to adopt the iron mills instead. Besides, the stone mill is occasionally pawned or hypothecated as security for debts, and is therefore looked upon as a more valuable property than the iron mill.

These appear to us to be the only reasons for the continuance of the use of stone mills ; otherwise they are admittedly inferior in all respects to the iron roller mills.

For all native *kolhus* the cane has first to be chopped into small bits (*genri*), the cuttings for the Gorakhpur wooden mill being much longer than those prepared for any other stone or wooden mill.

The typical stone mill of the east (Illustration I) consists of—

- (a) the *kolhu* proper or the mortar in which the *genris* (bits of cane) are crushed. The best *kolhus* are made from Chunár stone and cost from Rs. 40 to Rs. 50 each, including the price of stone and fitting expenses ;
- (b) the pestle or *játh*, which crushes the *genri*. It is usually the trunk of a *babul* tree, about 12 to 15 feet in length ;
- (c) the *taran*, a rope connecting the upper end of the *játh*, with the *kátar* or wooden beam on which the driver sits, and to which the bullocks are attached ;
- (d) the *kátar* or the wooden beam, which is geared to the *játh* by means of the *taran* and revolves as on a pivot round the mortar or *kolhu*, and thus gives the pestle or *játh* the necessary motion to crush the cane bits in the mortar or *kolhu* ;
- (e) the yoke attachment.

The upper portion of the mortar is hollowed, so as to form the following sections :—

- (1) the *kundi* or mortar proper, in which the bottom end of the pestle revolves, is about 12 inches in diameter and 8 to 10 inches in depth;
- (2) at the bottom of the *kundi* an outlet is made to enable the juice to pass from the *kundi* into an earthen receptacle. This outlet is called *naroh*;
- (3) above the *kundi* there is a sloped basin called *sirwá*, in which the *genjis* are actually crushed. Around the top of the basin there is a sloped channel called—
- (4) *chhiti*, which prevents bits of cane from falling out on the ground, as the motion of the pestle when revolving tends to push the pieces of cane upwards over the edge of the basin. The average height of a stone *kolhu* is about six feet, and nearly half of it is sunk into the ground. At a distance of about six inches above the ground a deep groove called—
- (5) *ráh* is cut round the *kolhu*, in which the *kátar* or beam attached to the driving gear revolves as on a pivot. The mouth of the *naroh* also opens into this groove and is joined to a
- (6) *nánd*, the receptacle for the juice by a small piece of bamboo called
- (7) *patnári*: over the mouth of the *nánd* a sieve is placed in order to strain the juice. The end of the pestle resting against the *kolhu* is rounded in such a manner as to fit the width of the *kundi*, and at a height equal to the depth of the *kundi* the *játh* is cut round so as to form the following parts :—
- (8) a ball called *mungar*, *mungri*, or *munri*;
- (9) the rounded upper end of the ball called *kánri*;
- (10) the main trunk gradually tapering upwards called *kán*; and
- (11) the uppermost point called *chur*. The inner surface of the *kundi* is lined with plates of wood called *páchar* (not visible in the diagram), in order to let the *mungar* move round properly, and also to protect it from constant friction against the stone of the mill. The *chur* on the pivot top end of the pestle rests in a wooden ladle (socket) called
- (12) *dhenká*, with the handle turned downwards. To this handle a piece of bamboo is attached, and to the bamboo a small rope called
- (13) *táran*: the gear or *kátar* is a shaft made of a plank of wood about five to six feet in length and about a foot or less in breadth. It is made to rest at one end on the *ráh*, with two pieces of wood like parts of a wheel on either side of this end. These two pieces of wood called

- (14) *kanmcgrá* and *jibheilá* (not visible in the drawing) form a semi-circular girdle of the mill, and the *kátar* can move round and round the *ráh* freely. At the other end of the *kátar* a piece of wood called
- (15) *márkham*, about a yard in height, is fixed perpendicularly. In this there are many holes, and to one of them a piece of wood is fixed crosswise protruding at both the sides of the *márkham*, and to it the *táran* is fastened and *kátar* suspended. At a short distance from *márkham* towards *kolhu* another hole is made in the *kátar* and a bamboo called *kárhá*, not visible in the diagram, is attached by a small rope called *dauli pachauñdhi*. Another rope, called.
- (16) *dauli agaundi* fastens the bamboo to an ordinary yoke. In some cases only the rope is used without the bamboo.

The oxen move round and round the *kolhu*, carrying the *kátar* and *táran* along with them. The turning of the *dhenká* gives a circular motion to the *játh*, and the *mungri* in the *kolhu* works accordingly. Between the *kán* of the pestle and the *scrúá* of the *kolhu* the *genri* is squeezed, and the juice makes its way into the *nánd* in the manner already described.

A *kolhu* similar to this is used in South Oudh, differing only in having its mortar made of wood instead of stone.

(2) *The cane-crushing wooden mill of Gorakhpur (Illustration II).*

The common sugar mill of Gorakhpur resembles the stone mill of the eastern districts in almost all particulars of construction. The stone *kolhu* of the eastern mills is replaced by wood; and, instead of a bottom channel to let out the juice in the stone mill, we have an outlet at the top and wooden pins take the place of rope *táran* of the stone mill. Native *kathal* (*Artocarpus integrifolia*) timber is almost wholly employed in its construction, and is moderately heavy and sufficiently strong to serve the purpose.

The mill may be of any size and dimensions, with a consequently varying capacity for work; but the two *kolhus* that are commonly found go by the names of (i) *thikarúá* (small size) and (ii) *raksúá* (large size). These two are exactly alike in construction, but differ in size and consequently in the capacity for work. The latter is much bigger than the former, and has a proportionately larger power for crushing the cane, but requires at the same time more power to work it and stronger draught cattle.

The arrangement for pressing is mainly composed of the following parts:—

- (a) The mortar or *kolhu*, and its accessories.
- (b) The pestle or *játh* or the cane crusher.
- (c) The gear or *kátar* with its attachments—yoking connections, yoke, cane-piece basket, vertical *harisá*, &c.

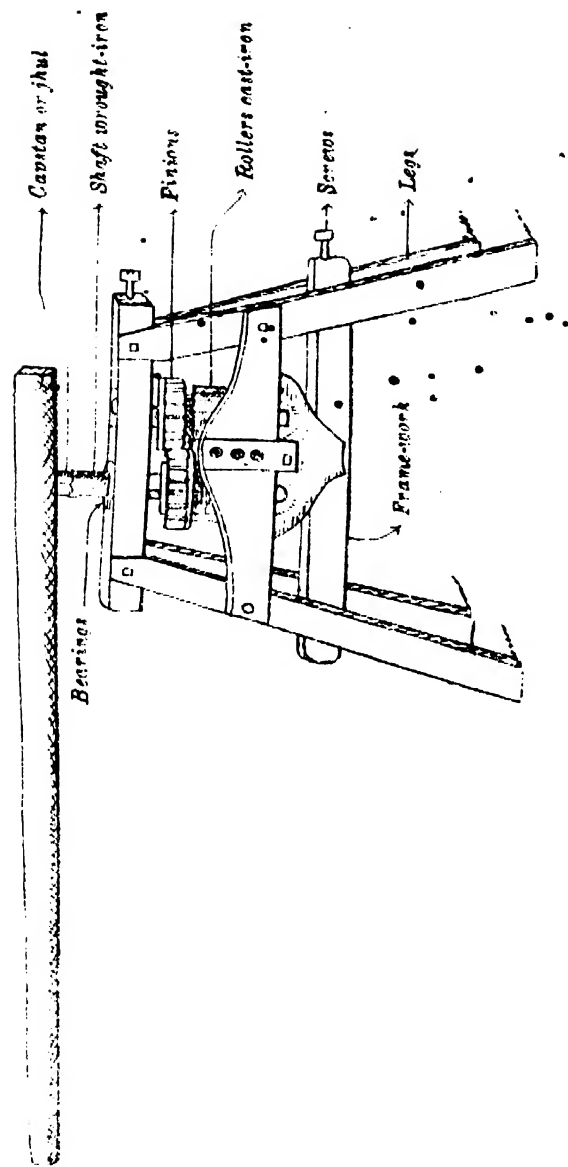
(a) *The kolhu with its accessories.*—(1) The *kolhu* proper is a cylindrical block of wood, about five feet in length and two feet in sectional diameter. The

upper portion of this block is hollowed inside so as to form a basin widening out upwards, and at the top a small channel called (2) *rawāni* is grooved round in the block. The other end is left untouched. After this preliminary formation of the block the solid end is buried under ground up to nearly half the length. Then at a convenient height above the ground a groove (of about six inches width) is cut round the *kolhu* to receive one end of the *kātar*. The channel made all round the top edge of the *kolhu* and known as *rawāni* is connected with a vertical channel reaching nearly halfway down the block. This vertical slit goes by the name of (3) *nardoh*. At the end of the *nardoh* a common *nariā* or curved tile-shaped piece of wood, called (4) *patnāri*, is fitted into the *kolhu* block. Below this *patnāri* an earthen pot called *chhannā* (not shown in the drawing) with perforations at the bottom is placed on the mouth of a large earthen vessel called (5) *gagri*. Now, when the *kolhu* is working, cane pieces are thoroughly bruised in the central cavity and the juice extracted passes first into the *rawāni*, then the *nardoh*, and then the *patnāri*, from which it falls down into the *chhannā* or strainer, and thence into the *gagri*.

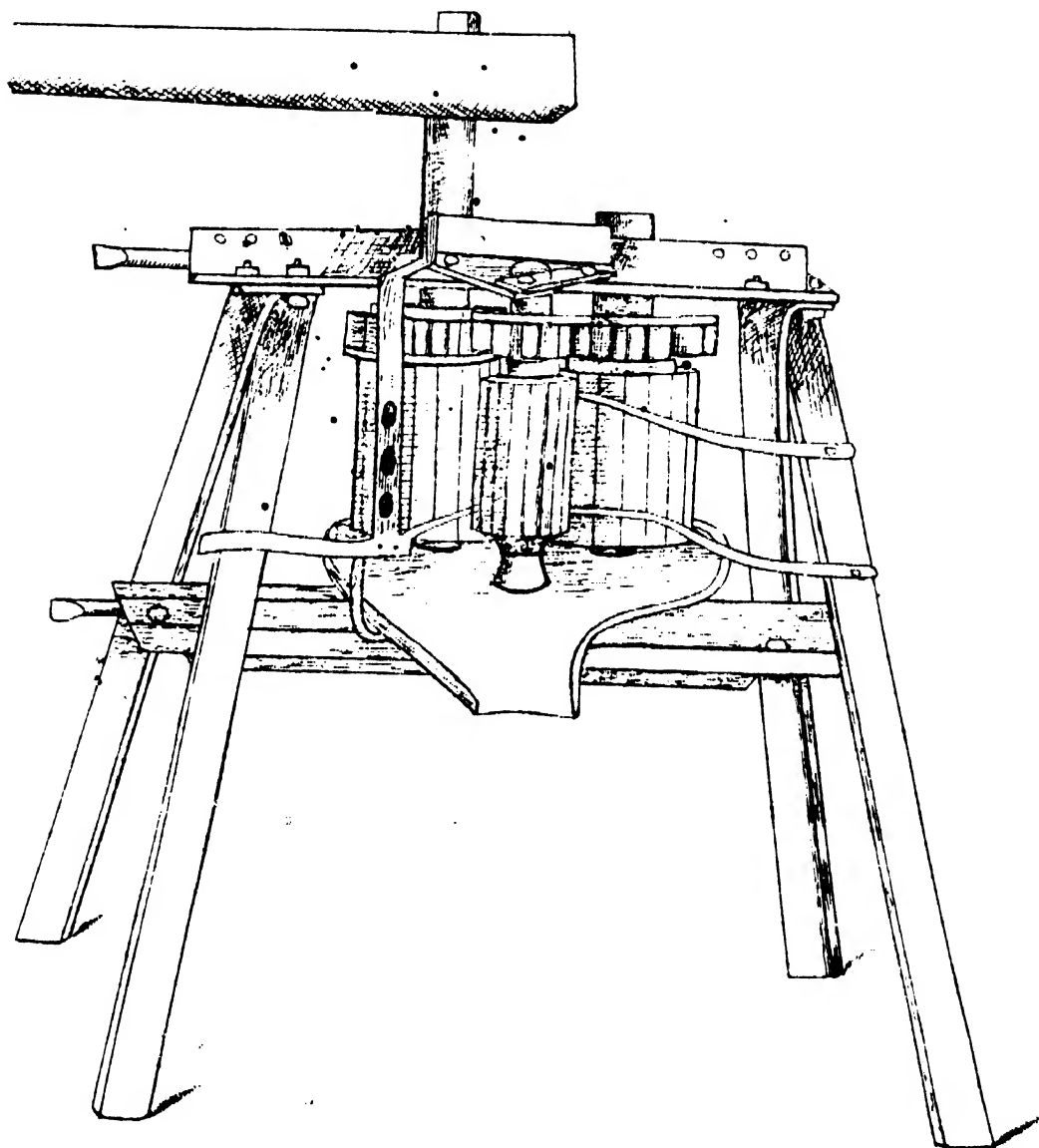
(b) *The jāth or the cane-crusher*.—This is the chief part of the whole cane-crushing mill. Upon its strength and weight and the fit of the knob at the lower end depends the efficiency of the mill. It is generally made of *kusum* timber. The lower end of the (6) *jāth* terminates in a rounded knob called (7) *kanth* perfectly fitting the cavity of the *kolhu*. On the upper side of the *kanth* there is a sharp notch all round the *jāth* to fit the narrow neck of the mortar and a gradual widening upwards to suit the upper basin of the *kolhu*. Pieces of cane are driven into the upper basin, and the *jāth* presses the cane and extracts the juice. The rounded end of the *jāth* and mortar cavity resemble a ball and socket.

The *jāth* is tapering to a point towards the upper extremity, and fits into the cup of a ladle-shaped piece of wood called (8) *dhenkā*, its handle hanging downwards. Thus when the draught bullock moves in a circle round the *kolhu*, the *jāth* being free at both the ends rotates round its own axis as well as round the *kolhu*. These two motions of the *jāth*, resembling a native oilman's press, facilitate the crushing and bruising of the cane. Connection between the *dhenkā* handle which we have referred to above and the flat beam or *kātar* down below is maintained by means of a bamboo piece called (10) *harisā*. It is pinned up to the *dhenkā* above, and is driven into and pinned downwards to the *kātar* below. The pins used are generally made of wood, and are locally called (9) *tāran*. The *harisā* may be raised or lowered at will by removing and refitting the *tārans* whenever desired.

(c) *The (11) kātar and its attachments*.—The *kātar* proper is a thick, wooden plank communicating force to the *jāth* by means of the connection—*harisā* with *dhenkā* on one side and the *kolhu* on the other. One end of this has got two semicircular lips [called (12) *kanmenṛā*] placed opposite to each other claspings the *kolhu* round the groove and turning upon it. A few inches apart from the lips some pegs are driven into the *kātar* to receive the cane basket. Towards



THE BEHEA TWO ROLLER IRON MILL



THE BEHEA THREE ROLLER IRON MILL.

the other end a set of small pegs is driven into the *kátar* and a strong rope attached. These pegs and rope form the yoking apparatus of the mill. At a little distance from the yoking pegs the *harisá* is fixed into the *kátar*, and close to the *harisá* and on the peg side of it another small bamboo structure, called (13) *killi*, is driven.

Working of the mill.—A single bullock is yoked to the mill and moves round and round in a circle, the *kátar* and parts attached to it being pulled round by the bullock. The driver sits on the *kátar* between the *killi* and yoking pegs, holding the latter in his left hand. When the animal moves, the *kátar* follows its motion, and communicates it to the *játh* in the manner already explained. Then by the motion of the *játh* cane which is fed to the *kolhu* very readily from the basket upon the *kátar* by a man standing there is crushed between the *játh* knob and *kolhu* hollow.

The juice thus extracted passes through the various channels into the *gagri* as already described.

(3) *The two-roller Behea iron mill (Illustration III).*

In this mill the cane-crushing is effected by means of two iron rollers set in a wooden frame.

Adjustment of the mill.—Four wooden legs, making a stand for the mill, are fitted to a strong wood framework, which holds the rollers in position and is tightly screwed up, the legs being buried in the ground, leaving the mill about two feet above the ground. The rollers are made of cast iron turned true on wrought iron shafts and the surface grooved vertically. The wrought iron shafts are fitted into holes made in the wood framework, and are geared together by means of two pinions at the top end of the rollers, but within the wood framework. The shaft of one roller is longer than the other and, passing through the top of the framework, projects above it. To this is attached a capstan (or *jhál*), in which is fitted a long pole for yoking to cattle. The rollers can be tightened or loosened by means of two screws, one for the top bearing and one for the lower. Thus one roller revolves in a fixed bearing and the other is adjustable by means of the screws. In front of the roller a thin, wooden plank, called “feed plate,” with three holes, is fixed by nails to the stand; the object is obviously to feed the mill with cane stalks regularly, and also to avoid the possible risk of the feeder’s hands getting between the rollers.

After adjusting the various parts of the mill in this way, a long wooden pole of about eight to ten feet is fixed upon the projecting axis of the left hand roller and the bullock is yoked to its further end.

Working of the mill.—The draught cattle always move round the mill in a circle from left to right, i.e., opposite to the direction of the hands of a watch, and when the animal moves the left roller rotates on its axis in the same direction and the pinions of this communicate the motion to the other roller through its pinions and cause it to move in the opposite direction. A man sitting with a heap of cane stalks in front feeds the mill with them through the holes, and these

cane pieces are caught and crushed by the rollers moving. The juice as it is extracted falls down from the rollers into the basin, from which it runs out through the spout into a receptacle below.

(4) *The three-roller Beheá iron mill (Illustration IV).*

This mill is an improvement upon the two-roller Beheá mill described above. It consists of the framework made of wrought iron, four legs made of angle iron which are crossed near the top and bolted together, and three rollers. The arrangement of screws in both mills is based upon one and the same principle. The rollers are made of cast iron and the shafts of wrought iron. The bearings are made of brass to prevent wear and tear of shafts. The frame is fitted with two rollers of equal dimensions and a third roller of smaller dimensions; thus the cane is first bruised between one pair of rollers and then crushed completely in the other.

The small roller gears with the main roller and the main roller with its companion, that is, the main roller when set in motion moves both the companion roller and the small roller.

This small roller is placed in front of the two large rollers a little closer to the main roller.

A wrought iron plate crooked or bent in shape is fixed in front of the companion and the large rollers touching the former and forcing the cane into the companion and the main rollers.

The plate is bolted to the fourth leg at both ends.

These mills, when in good order, extract a high percentage of cane juice, and are gradually superseding the two-roller mill.

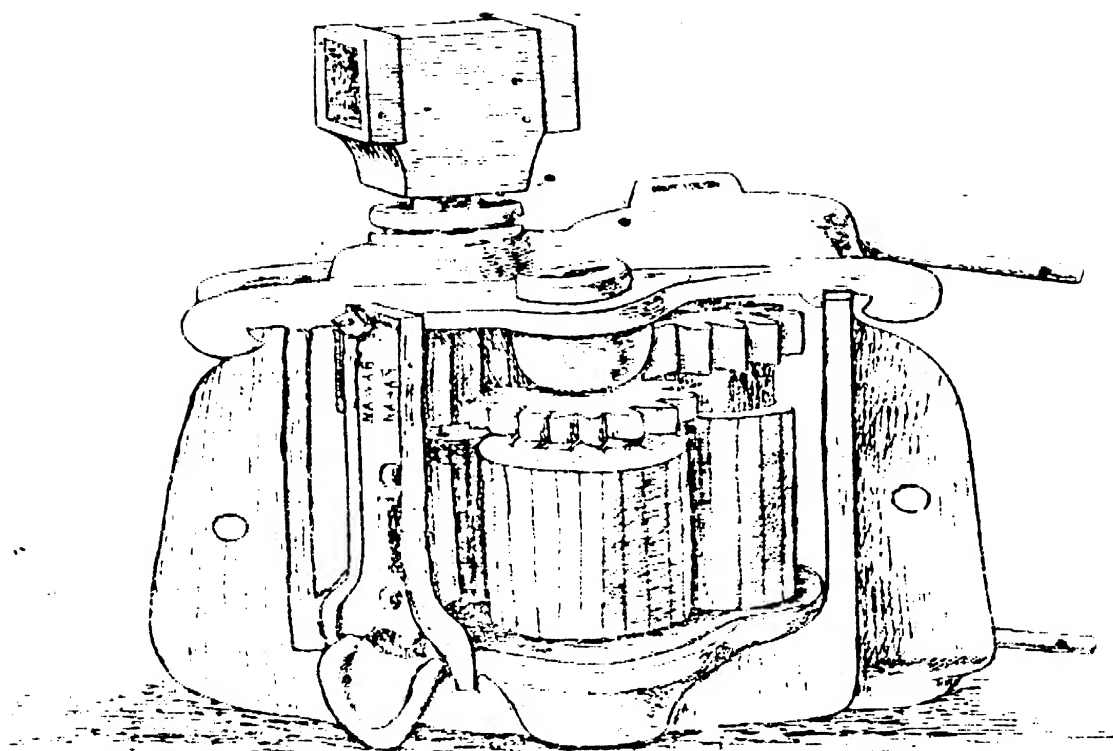
(5) *The Náhan three-roller iron mill (Illustration V).*

This mill consists of four wooden legs (not shown in the diagram), a frame of cast iron, and three iron rollers. The shaft of the third roller does not revolve, but remains fixed and the roller itself revolves round its shaft.

The pinion of the main roller is as thick as the pinions of the companion roller and the third roller taken together, so as to enable the upper portion of the pinion of the main roller to gear with the pinion of the companion roller, the lower portion gearing with the pinion of the third roller. The pinions and rollers are cast on to the shafts and revolve together.

The cane is first bruised between the main roller and the third roller, and, then passing through the companion and the main rollers, is completely pressed.

Iron mills having more than three rollers have not yet been introduced in these Provinces. The only exception is the Bábu mill, a patent of Bábu Bhawani Dass of Bijnor, which has four rollers in it. This mill is slowly gaining ground in parts of the Meerut and Rohilkhand Divisions, and is at present sold and let to cultivators on hire by Mr. C. F. R. Simpson of Malikpur, Anúpsahr, district Bulandshahr. According to our own experience, this is undoubtedly one of the efficient cane-crushing mills in use in our country.



THE NAHAN THREE ROLLER IRON MILL

Besides the mills which are described above, there are numerous other patterns in use or on the market. The differences in the construction are for the most part minute, and the mills do not call for separate description.

The relative merits of the different mills.

In course of our investigations we had no evidence to show that the common two-roller Beheá mills extracted a higher percentage of juice than the old-fashioned stone or wooden mills. But the superiority of the iron roller mill over the country mill in other respects is obvious. The former crushes the cane evenly, and does not grind it as the *kolhu* does; consequently the juice is cleaner and more free from vegetable acids and yields better sugar. It saves the labour of cutting the cane into strips and can be worked by two men and one bullock instead of three men, two boys, and two bullocks ordinarily required by the country *kolhu*.

We have on several occasions compared the work of the common two-roller Beheá mills with that of the three-roller Beheá, and quote below the results obtained in a few instances:—

| District. | Kind of cane crushed. | Average percentage of juice obtained when the cane was crushed with the two-roller mill used by the cultivator. | Average percentage of juice expressed when the cane from the same crop was crushed by the three-roller Beheá mill. |
|--------------------|-----------------------|---|--|
| Fyzabad | Sarauti | 52·27 | 62·50 |
| Farrukhabad | Chin | 56·33 | 61·06 |
| Unao | Do. | 50·01 | 58·11 |

These figures show that a more extended use of the three-roller Beheá mill is very desirable, as it would be a direct source of gain to the cultivator, who would be in a position to turn to good account the portion of juice that is at present wasted.

The three-roller Náhan mills, which are also more efficient than the two-roller Beheá mill, are now largely used in the Meerut Division, and the percentages of juice obtained ordinarily from cane as shown opposite districts of that division in the statement on page 104 are those actually extracted by the *Náhan* mill. There seems to be little doubt that a material increase in the outturn of raw sugar in the country can be effected by the mere replacement of the two-roller mills with the more efficient (but more expensive) three-roller mills. This is, however, a piece of work which landlords alone can be expected to do properly.

CHAPTER VI.

MANIPULATION OF THE JUICE AND MANUFACTURE OF RAW SUGARS.

(1) *Gur*, and its various forms.

Gur, the most common form of raw sugar, is a compost of sugar crystals and molasses, into which the greater part of the juice produced in the country is

ordinarily converted. The juice expressed from the canes is usually collected in the "*nānd*" or "*matā*" (an earthen vessel), which is sunk in the ground near the mill. The mouth of the *nānd* is generally covered with a rough

FIG. 4.



reed filter (Figure No. 4), "*chhannā*," with a view to prevent the refuse and small bits of cane from passing into the earthen reservoir. Where wooden and stone mills are used, there is also a small tank near the mill called "*darbā*," into which the

refuse from the pressing mill is transferred. Water is then thrown over the refuse to carry down with it the unexpressed juice through a hole into another reservoir or *nānd*. In the eastern districts the pure juice is called "*abgā*" and the juice mixed with water is known as *panihā* or *rasi*. When the *nānd* near the

FIG. 5.



mill is full to the brim, the juice is removed by means of a "*saikā*" or "*saiyyā*" (Figure No. 5), an earthen jar provided with a handle, and put into a number of "*nānds*" or *bhanni* fixed in the ground near the boiling pan. This set of earthen *nānds* with the mud structure outside the boiling house supporting them is called "*otā*." The iron pan inside the boiling shed

is fitted on an earthen structure built over a furnace (*bhatthi*), which has a big hole in front through which the fuel is supplied. The furnace, together with the thatched shed in which boiling takes place, is called "*gulaur*" (boiling house). In places where the stone or wooden mills are used another shed known as "*geranni*" is attached to the *gulaur* in which the canes are chopped.

Boiling.—In the west a set of three boiling pans is generally used. The first and the third are called "*bel-kā-karāh*," and the second placed in the middle goes under the name of "*parchhā*."

The juice is first heated in the first pan. When the scum rises to the surface it is removed and the boiled juice transferred to the third pan, where it undergoes further concentration and is then baled out to the *parchhā* in which the boiling is completed. In the East only one pan is used in which the whole process of boiling is carried out.

The single pan process is described below :—

When the fire is strongly lighted and the furnace well heated a basket of wickerwork with a cloth strainer called "*lothā*" over it is placed above the pan, and the requisite quantity of juice is filtered through it. The juice is then boiled down slowly, the man in charge of this operation being always careful not to allow it to boil over. In the course of this process the scum appears on the

FIG. 6.



top and accumulates to the side of the pan. It is removed with a "*dori*" or "*paunā*" (a perforated iron ladle) and collected into the "*matki*" or "*kohā*" (Figure No. 6) (an earthen basin) kept close to the pan for the purpose. The scum, which is called "*mahi*" or

"*mail*," is generally given to cattle and occasionally even eaten by the poor. Milk or *ghā*, crude carbonate of soda, infusion of castor seeds or of the roots of the *bhindi* plant (*Hibiscus esculentus*) are used for the purpose of clarifying the syrup.

* In the Saháranpur and Dehra Dún districts, when the special form of *gur* known as *andarki* (to be described presently) is made, the bark of the *palu* tree is thrown into the juice to clear off the impurities present in it. The following clarifying mixture recommended by a professional boiler of Sháhjahánpur has been repeatedly tried in the Agricultural Department and found to answer well:—

Bugloss (*gáo zabán*) 2lbs. and *káli sajji* (crude carbonate of soda) $\frac{1}{2}$ lb. are steeped in 12lbs. of water for 24 to 30 hours. The mass is then well rubbed between the hands and the liquid strained through a fine piece of muslin. One *tola* or about three drams of powdered alum is added to the liquid. The latter is then boiled till it is reduced to half its original bulk. It is then strained again through a fine piece of cloth and poured into a bottle, which is well corked. One ounce of the mixture is added to each panful of juice after the scum has been removed in the ordinary course. On its addition scum again comes up and is taken off. The mixture keeps only for a week or ten days. The only objection to the use of this mixture lies in the presence in it of the soda alkali, which, according to chemical experience, prevents a certain amount of sugar in the juice from crystallizing. There is, however, no doubt that it imparts a beautiful colour to the resulting *gur*, and thus enhances its value in the eye of the purchaser requiring it for consumption as food.

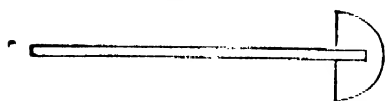
Experiments in liming the juice at the Government Experimental Farm, Cawnpore, have proved that the percentage of crystallizable sugar in the *gur* is thereby increased, but that the *gur* assumes a more or less dark colour. The raw material obtained from limed juice is consequently of greater value to the refiner. Thus, when a cultivator is making *gur* for use in a refinery, the best results would be attained by neutralizing about three-fourths of each panful of his juice with “milk of lime” and adding the remaining one-fourth to the pan before boiling. The milk of lime should be prepared by adding four *chhatáns* or eight ounces of burnt lime to five seers or one gallon of water, agitating the mixture till the liquid becomes milky. One-fourth of each pan of juice should be set apart and small quantities of this liquid “milk of lime” should be thrown into the remaining three-fourths, and the juice tested with a piece of blue *litmus* paper. It will then probably turn pink in colour. A little more milk of lime should then be added and the *litmus* paper dipped again. The *litmus* paper will probably change its colour again, but the shade of pink will be lighter this time. More milk of lime should be gradually added in this manner and the juice tested with *litmus* paper after each addition, till only a very slight change in the colour of the paper takes place. The juice should then be taken as nearly neutralized.

The portion of the juice not treated with lime should then be added to the limed juice and the mixture boiled in the usual way. The objection to the introduction of this process among ordinary cultivators is the use of litmus; endeavours have been made to devise some simpler indication of the neutralization point, but so far without success. The acidity of the juice varies so greatly

that no rule of thumb can be suggested which would be suitable for general adoption.

In many districts of the United Provinces no clarifying ingredients are added

FIG. 7.



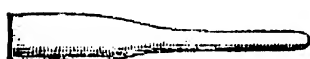
to the juice in the case of *gur*-making. As the boiling liquid thickens it changes to a brown yellow colour and has to be kept in continued motion with the *pharuhi* (Figure No. 7) (a wooden stirrer). When it is considered that the juice is thoroughly boiled, which is known by the appearance of bubbles called "*phut*" on the surface, the thick syrup is tested by taking a little of the *qirám* or *pág* (the thickened syrup) between the forefinger

FIG. 8.



and thumb and rolling it, so as to form small balls, which should be semi-solid. This test having been tried, the sugar boiler transfers the liquid by the "*dori*" (Figure No. 8) into an earthen receptacle called "*cháak*" or "*niyáá*," which is placed close to the pan. It is then worked with a "*khurpi*" or "*dauwá*" (Figure No. 9) till its

FIG. 9.



température comes down to a degree which renders it possible to touch the mass with the hand. When it solidifies, the product known as *gur* is ready. The *gur* is then made into *bhelis* (balls) of different sizes and weights, and kept outside in wooden baskets to dry. After this they are ready for sale in the market.

In South Oudh wood ashes are, as a rule, applied to the palms of the hand before working the hot stuff into *bhelis*, in order to prevent it from sticking to the skin. The common *bheli* of the western districts is similar in shape to the cottage loaf, and is much larger than the *bhelis* of the eastern districts, which are perfectly round.

In Azamgarh and Benares *muthiá* is generally manufactured instead of *bheli*, and differs from the latter in being more or less triangular and much smaller, being only as much in quantity as a *mutthi* (closed fist) would hold. *Muthiá* enjoys much reputation as a form of raw sugar specially suitable for eating, and much cleanliness is usually observed in manufacturing it throughout the various operations. *Muthiá* is never used for refining purposes owing to its comparatively high cost. Sometimes cloves, cardamoms, powdered ginger, pieces of cocoanut, and other spices are added to the boiling juice. The *gur* is then called "*masáladár muthiá*." Such *muthiás* are eaten as a luxury and sent as presents to friends.

In eastern districts the common *gur* is classed under four heads in the market, *viz.*,—

- (1) *Chinihá* or *danahá*—Which is very rich in crystals and soft in texture. It is considered to be pre-eminently fitted for refining. The *gur* that comes from the neighbourhood of Maghar in the Basti district is mostly of this class. It is known as *maghar*, and is highly esteemed by refiners.

(2) *Latthá*.—This is hard and poor in crystals. It is seldom used for refining except by mixing it in a small proportion with *chinihá*. It fetches a comparatively low price, and is used largely for eating.

(3) *Chingá*.—This is harder still, and results when the thickened juice gets overheated by accident or carelessness. It is never used for refining.

(4) *Lit, litá, or litahá*.—When on account of careless boiling, excessively wet weather, or particularly poor quality of the juice (such as the juice expressed from fallen canes) the *gur* fails to solidify, it is known as *lit, litá, or litahá*.

When *pári* and not *bheli* is the object, the boiled mass is poured into earthen moulds (Figure No. 10), where it cools and solidifies, assuming the shape of the moulds. These lumps are known as *pári*.



A statement is attached, showing the weights of the *bhelis* and *páris*, such as are ordinarily manufactured in certain districts of the United Provinces :—

| District. | | | | | | | Weight of <i>pári</i> in seers. | Weight of <i>bheli</i> in seers. |
|---------------|-----|-----|-----|-----|-----|-----|---------------------------------------|--|
| Dehra Dún | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Saháranpur | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Muzaffarnagar | ... | ... | ... | ... | ... | ... | 5 | 2½ |
| Meerut | ... | ... | ... | ... | ... | ... | 5 | 2½ |
| Bulandshahr | ... | ... | ... | ... | ... | ... | 5 | 2½ |
| Aligarh | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Muttra | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Agra | ... | ... | ... | ... | ... | ... | 10 | ... |
| Farrukhabad | ... | ... | ... | ... | ... | ... | 13½ to 20 | ... |
| Mainpuri | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Etáwah | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Etah | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Barcilly | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Bijnor | ... | ... | ... | ... | ... | ... | ... | ... |
| Budaun | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Moradabad | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Sháhjahanpur | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Pilibhit | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Cawnpore | ... | ... | ... | ... | ... | ... | 13½ | ... |
| Fatehpur | ... | ... | ... | ... | ... | ... | ... | ... |
| Bánda | ... | ... | ... | ... | ... | ... | ... | ... |
| Hamirpur | ... | ... | ... | ... | ... | ... | 4 to 8 | ... |
| Allahabad | ... | ... | ... | ... | ... | ... | ... | ... |
| Jhánsi | ... | ... | ... | ... | ... | ... | 5 to 6 | ... |
| Jalaun | ... | ... | ... | ... | ... | ... | ... | ... |
| Benares | ... | ... | ... | ... | ... | ... | ... | ½ to 1 |
| Mirzapur | ... | ... | ... | ... | ... | ... | ... | ½ to 1 |
| Jaunpur | ... | ... | ... | ... | ... | ... | ... | ... |
| Gházípur | ... | ... | ... | ... | ... | ... | 10 | ... |
| Ballia | ... | ... | ... | ... | ... | ... | 20* | ... |
| Gorakhpur | ... | ... | ... | ... | ... | ... | ... | ... |
| Basti | ... | ... | ... | ... | ... | ... | ... | ... |
| Azamgarh | ... | ... | ... | ... | ... | ... | ... | ... |
| Almora | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Garhwál | ... | ... | ... | ... | ... | ... | ... | 2½ |

* Known as *chakri*.

| District. | | | | | | | Weight of <i>pári</i> in seers. | Weight of <i>bheli</i> in seers. |
|--------------|-----|-----|-----|-----|-----|-----|---------------------------------------|--|
| Naini Tal | ... | ... | ... | ... | ... | ... | 20 to 40 | 2½ |
| Lucknow | ... | ... | ... | ... | ... | ... | ... | ... |
| Unao | ... | ... | ... | ... | ... | ... | ... | ... |
| Rae Bareilly | ... | ... | ... | ... | ... | ... | 20 | ... |
| Sitapur | ... | ... | ... | ... | ... | ... | ... | ... |
| Hardoi | ... | ... | ... | ... | ... | ... | 8 to 20 | ... |
| Kheri | ... | ... | ... | ... | ... | ... | ... | ... |
| Fyzabad | ... | ... | ... | ... | ... | ... | ... | 1 |
| Gonda | ... | ... | ... | ... | ... | ... | ... | 1 to 1½ |
| Bahraich | ... | ... | ... | ... | ... | ... | ... | 2½ |
| Sultánpur | ... | ... | ... | ... | ... | ... | ... | 1 |
| Partábgarh | ... | ... | ... | ... | ... | ... | ... | 1 |
| Bara Banki | ... | ... | ... | ... | ... | ... | ... | 1 |

Andarki is a form of *gur* manufactured in some of the western districts, chiefly in Saháranpur and Dehra Dún.

In this case the process just described with reference to the manufacture of *gur* is closely followed. When the juice is thoroughly boiled, it is emptied into another pan, where it is kneaded with the "*masid*" (wooden spoon) till it becomes cool and properly consistent. It is then laid on a mat with a wet cloth spread over it. As soon as the mass is sufficiently dried, it is cut with knives into oblong bits (*andarki*) and collected into baskets.

From the extraction of juice till the completion of the manufacture the whole process requires the services of a large number of persons, and thus affords employment for a good many day labourers, besides the carpenters who are required to repair from time to time, and set up the *kolhus* in the districts where the wooden and stone mills are worked. These men are paid in different ways in different districts. Not uncommonly, however, the cultivators of the same, and sometimes of two conterminous, villages club together to help each other in cutting their crops and making the *gur*, the labour being divided among themselves and the order in which each cultivator's crop is to be taken in hand being settled by mutual arrangement. In this way labour is seldom actually paid for, while it is rendered available at the proper time.

The following is a fair estimate of the cost per acre of cutting and crushing an average crop of sugarcane and converting it into *gur* by hired labour:—

| | Rs. | a. | p. |
|---|-----|----|----|
| (1) Forty men are sufficient to cut, strip, and carry up the canes of an acre of land from the field to the <i>kolha</i> . Their wages, if calculated at two annas per head, will amount to | 5 | 0 | 0 |
| (2) The hire of an iron mill at eight annas a day for 15 days, during which period the canes will be crushed | 7 | 8 | 0 |
| (3) Hire of bullocks for the same period (two pairs at eight annas each) | 15 | 0 | 0 |
| (4) „ <i>karāh</i> (the boiling pan) at two annas a day for 15 days | 1 | 14 | 0 |
| (5) Wages of <i>muthiā</i> (the man who keeps the mill supplied with pieces of cane and feeds it) at two annas a day for 15 days | 1 | 14 | 0 |
| (6) Wages of <i>jhokā</i> (the labourer who feeds the furnace and regulates the heat) at two annas per diem or 1½ seers of <i>gur</i> per day for the same period | 1 | 14 | 0 |
| (7) Price of <i>chāk</i> and other earthen vessels | 0 | 8 | 0 |
| (8) Fuel in addition to <i>khoi</i> (mill refuse) | 2 | 0 | 0 |
| (9) Oil | 0 | 6 | 0 |
| Total | 36 | 0 | 0 |

The total cost of manufacturing *gur* thus comes to Rs. 36 per acre.

If a stone or wooden mill be used, the labour will run up to a very high figure, which we make no attempt to determine here, because (1) the use of those mills is not extensive, and (2) where they are in use the cane-growing cultivators, as a rule, help each other in the harvest by simple interchange of labour without one party paying the other for the work done by him.

(2) *Ráb*.

Another form of raw sugar, almost as important as *gur*, is the article known as *ráb*, into which the greater part of the juice produced in the Rohilkhand and Meerut Divisions is generally converted. It differs from *gur* in being of a thinner consistency and is used chiefly for the manufacture of the refined sugar called *khánd* or *kachchi chini* as distinguished from *pakki chini*, which is largely manufactured from *gur*, *ráb* being used for the manufacture of *pakki chini* only in parts of the Gorakhpur Division.

Ráb is prepared under two different systems of manufacture, viz., the *sáir* system and the *bel* system.

(a) *Manufacture of "ráb" under the "sáir" system.*

This method is, as a rule, followed by the cultivators who work with their own juice. The process of manufacture and the appliances used are identical with those employed in the manufacture of *gur*, the only difference being that the boiling is not so prolonged as in the case of *gur*. The syrup, when ready, is removed from the pan and kept in *kalsis* or *nánds* to crystallize. *Sáir ráb* is generally of two kinds, viz., (1) *dharkauwán* and (2) *bandhuwán*.

The latter is somewhat thicker than the former and richer in crystals, being manufactured with pure and filtered juice, which is also clarified. The former is prepared from a mixture of pure juice and *rasi* (the juice mixed with water) without being filtered or clarified, and is therefore less prized by the refiner.

(b) *Manufacture of "ráb" under the "bel" system.*

The term *bel* literally means a tendril, something which protends itself or grows onwards, and is applied to the peculiar system of manufacturing *ráb* in which the cane juice is boiled in a set of five pans, being transferred successively from one into the other pan in the course of boiling till it acquires the requisite consistency of *ráb* in the last pan, the primary sense of the term being conveyed by the fact of the process of boiling being so to speak elongated. The *bel* system is most prevalent in Rohilkhand, and is unquestionably superior to the *sáir* system, in which the boiling is generally confined to a single pan. The former is followed almost exclusively by the *khandsári*, who purchases the juice from cultivators and the latter almost entirely by the cultivator with his own juice and crude appliances. With regard to quality, the *bel ráb* is always richer in crystallizable sugar than the *sáir ráb*, the former yielding as much as 35 per cent. of *khánd* in refining; while the latter, even when the best of its kind, does not produce more than 33. The *khánd* made from *bel ráb* is always whiter in

colour as compared with the produce of the *sáir ráb*, and the two kinds of *khánds* are readily distinguished from each other by sugar experts. The molasses (*shírā*) of the *sáir ráb*, however, always contain a higher percentage of crystallizable sugar than those of the *bel ráb* and are consequently more profitably used for the manufacture of the inferior class of *khánd*, a bye-product known as *doyam* or *galáwat-ki-khánd*. The superiority of the *sáir* molasses is due to the fact that the crystals of *sáir ráb*, being comparatively fine, dissolve more easily and pass out in solution in greater quantity with the molasses in the manufacture from the *ráb* of the semi-drained raw sugar known as *potli* or *putri*.

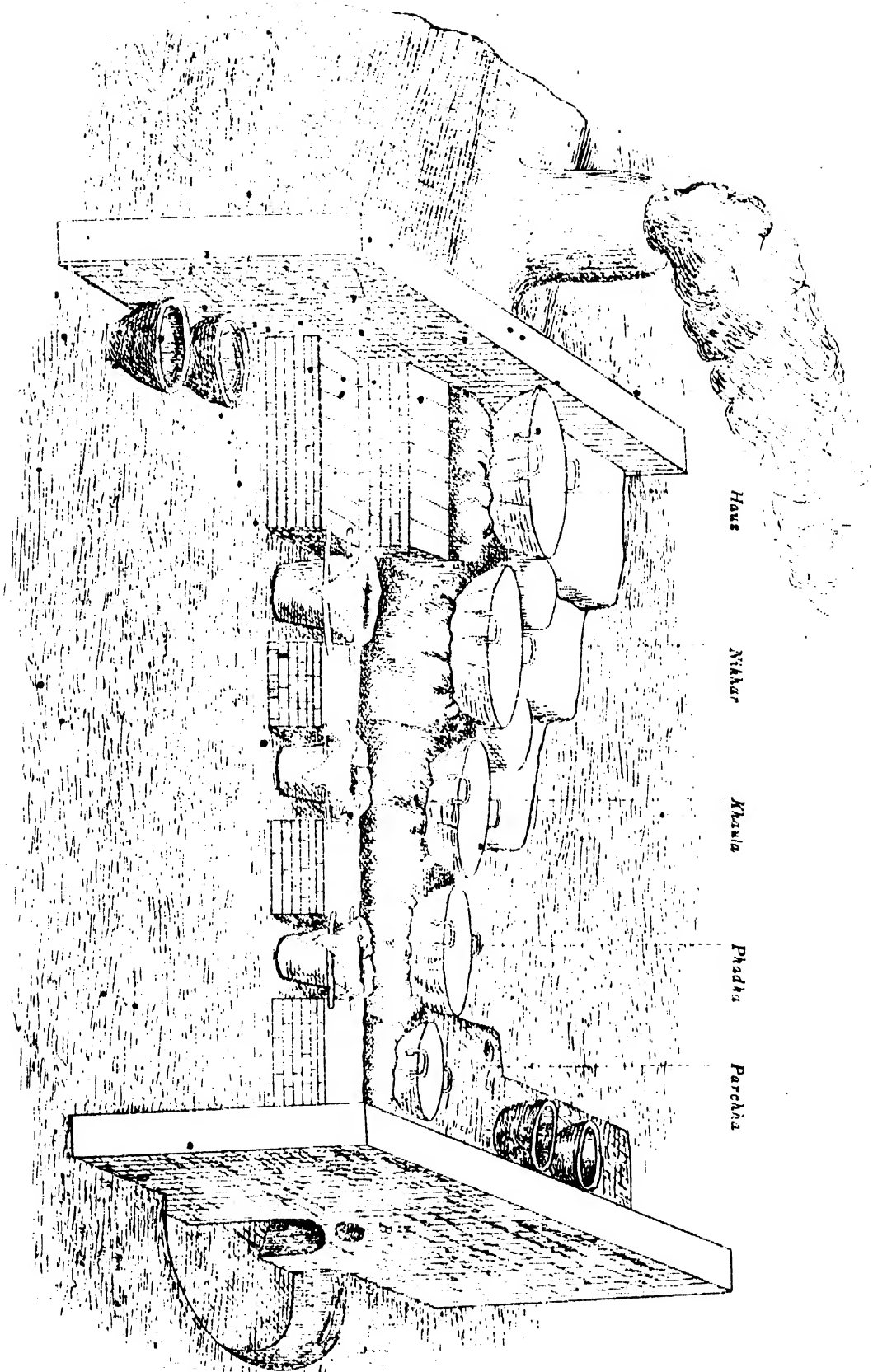
The building temporarily erected for the *bel* is a modest one, consisting of four mud walls thatched over with grass, an opening being, as a rule, left in the roof to allow the vapour of the juice to escape freely. Outside this hut is the open yard where the mills work. From 9 to 12 *kolhus* are ordinarily worked for each system of five pans. Sometimes two systems of five pans each are worked in the same building, and the *bel* is then called a *dohri bel*, the number of the mills attached to the factory being also doubled.

The furnace, which is provided with a flue (*dhándhu*), is a subterranean excavation across the breadth of the shod and has two orifices outside, one (*bilaiyá*) for feeding the furnace with fuel; and the other (*pardá*) for taking out the ashes. Over the furnace are fixed the five boiling pans in the manner shown in Illustration VI in a row, so that the largest pan is furthest from the feed end of the furnace and the smallest directly over it. On either side of the largest pan a mud platform is raised. On one of these platforms two earthen troughs (*nánds*), not visible in the diagram, are sunk to contain the clarifying mixtures. On the other platform two or three earthen pots are sunk similarly, to receive the scum. At the foot of the wall and on one side of the smallest pan a set of two or three *nánds* is let into the ground, in which the *ráb* is stored for cooling.

The appliances.—The following is a list, with a brief description, of the various appliances used in the *bel*:—

The system of five iron pans consists of—

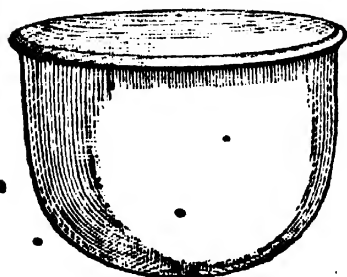
- (a) *Hauz* ("the tank"), the largest pan, which serves as the first receptacle for the juice. It has a diameter of about eight feet and contains about 50 maunds of juice.
- (b) *Nikhár* ("the clarifier"), the second pan or the one next to the *hauz*; diameter about 6½ feet; contains about 32 maunds of juice. In this pan the juice is heated till the scum comes up and is removed.
- (c) *Khaulá* or *phulá* ("the boiler"), the third or the middle pan, so called as boiling proper begins in this pan; diameter about four feet; contains about 16 maunds of juice.
- (d) *Phadká* (from *phadakná*, to bubble), so called because the juice boils with greater force in this than in the third pan; diameter about four feet; contains about six maunds of juice.



THE BEL.

(e) *Parchhā* ("the last") is the fifth and the smallest pan in which juice concentrates finally into *rāb*; diameter about two feet eight inches; holds about 16 seers of juice.

FIG. 11.



Nāndās (Figure No. 11) are the three earthen troughs to the left hand side of the *parchhā*, the one nearest to the latter being connected with it by means of a channel (*parnāli*), which is the passage for *rāb*. In these troughs the *rāb* is cooled down.

FIG. 12.

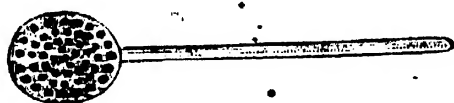


FIG. 13.

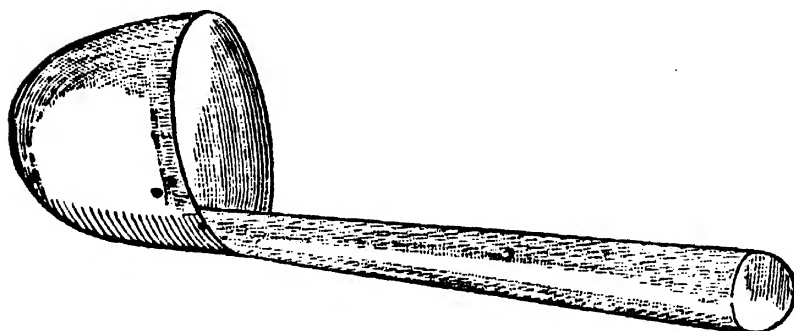


FIG. 14.



FIG. 15.

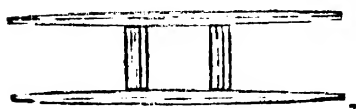


FIG. 16.



Paunā (Figure No. 12), a perforated ladle for skimming off *patoī* from the *nikhār* and "mail" from the other pans.

Karangā (Figure No. 13) is a ladle for carrying juice from one pan to another.

Dori (Figure No. 14) is similar to *karangā*, but of smaller dimensions than the latter, and is used for disturbing the *rāb* in the *nānds* in order to cool it.

Tipāi (Figure No. 15) is a wooden stand resembling a ladder of two steps, and supports a *jhanwā* (Figure No. 16) (basket of wicker work), over which a cloth filter is

tied. Below the *tipāi* there is a *nānd*. When the skimmings are put over the filter, the scum proper remains above the filter, while the small quantity of juice mixed with it makes its way into the *nānd* below.

FIG. 17.



FIG. 18.

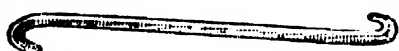


FIG. 19.



FIG. 20.



FIG. 21.



Kunchi (Figure No. 17) is a small brush for sprinkling the clarifying matter over the juice while boiling in pans.

Kauru (Figure No. 18) is an iron bar curved at both the ends used for taking out the ashes from the furnace.

Dôchi (Figure No. 19) is a small jug with a handle, and is used for taking out the juice from one vessel and pouring it into another.

Matâ (Figure No. 20) is a large earthen jar sunk into the earth close to the crushing mill to receive the juice expressed. It forms a standard of measure for the quantity of juice received by the proprietor of the *bel* or delivered by the cultivator, but varies in capacity, usually holding from three to four maunds of juice.

Karsi or *kalsi* (Figure No. 21) is the earthen *gharâ*-shaped jar in which *râb* is filled when ready and kept till required for refining.

The process of manufacture.—First of all the five pans are thoroughly cleaned by prolonged rubbing of stones against their inner surface and copious washings with plain water, so as to remove as much as possible the rust and any other dirt that may be sticking to the surface, uncleanness being considered to affect seriously the quality and colour of *râb*. This operation is carefully repeated daily before the boiling is started. Juice is then brought by the *bhishti* from the several *matâs* attached to the cultivator's mills working outside and collected in the *haus*. A piece of ordinary cloth is suspended to serve as a strainer, and the *bhishti* empties his *mashk* of juice over the strainer, so that the juice may get filtered while entering the *haus*. *Khoi*, the mill refuse or "*begass*," is collected and exposed to the sun. When dry, it is used as the fuel for boiling. At first it is shoved into the furnace through either of the two orifices called "*bilaiya*" and "*parda*," and fire applied. The "*parda*" is then closed with mud in order to prevent dissipation of heat, the furnace being then fed through the "*bilaiya*" alone. When the *begass* is not sufficiently dry, as is usually the case at the commencement of the operations, firewood, chiefly *dhâk* (*Butea frondosa*), is used till the *begass* is fit for use. Thus the use of firewood is indispensable during the first two or three days when the *bel* is started, and again when the weather is rainy or cloudy. *Begass* would undoubtedly make a capital manure for sugarcane, and its manurial value

has been invariably recognised in Queensland and other sugar-producing countries; but as no fuel can be had readily in India at the same cheap cost as the *begass*, and the *khandsári*, who does not ordinarily grow much cane himself, cares little about the manurial value of the refuse, the whole of it is burnt in the boiling furnace. Besides, the cultivator cannot afford to pay the cost of carting the material back to his fields, and his juice is usually bought on the distinct understanding that the refuse will be handed over to the *khandsári* for burning. In justification of the *khandsári's* action it may be stated that if he were to use ordinary firewood, the cost of manufacture would run up to such a high figure as to leave little margin for a profit.

• When the juice has been warmed to a certain degree in the *haus*, a portion of it is transferred to the *nikhár*, in order to be clarified by the addition of certain clarifying agents. The following recipe of a mixture commonly used in Rohilkhand is sufficient for a *mafa*-ful of juice:—

Sajji (crude carbonate of soda), two ounces.

• Decoction of *bhatkataiyá* or of *fálsá* bark, $\frac{1}{2}$ lb.

Infusion of the stem of *deulá*, a kind of *hybiscus*, 2 lbs.

The bark and the stems are added to the water in indefinite quantities, but enough to yield a mucilaginous liquid.

Small quantities of this mixture are added to the boiling juice at intervals to assist separation of the scum (*patoi*), which is taken off by means of a *pauná* and placed over a cloth strainer spread over a *jhawwá* (basket) placed on the *tipái*. A little juice always comes off with the scum, and this filters through the strainer into the *hánd* below the *tipái*, the real refuse alone being left on the strainer. The manner in which this juice is disposed of will be described presently. When the *patoi* has been skimmed off about half a dozen times, the juice is considered to be nearly free from matters which it is desirable to eliminate. It is then removed into the *khaulá* or the third pan, and is boiled well. Any further scum rising up is again taken off. In the course of boiling, if an overflow is apprehended, a mixture of crushed castor seeds with water is sprinkled on the surface of the boiling liquid with the *kunchi*, a brush-shaped implement, and this process at once suppresses the violence of boiling. At a certain stage of boiling the juice is removed from the *khaulá* into the fourth pan, the *phadká*, where it further concentrates. From *phadká* the concentrated liquid is brought into the *parchhá*, the fifth and the last pan, in which the final degree of concentration is attained.

• It requires an experienced eye to mark the stage when the liquid is ready for being transferred from one pan to another, the stages being, as a rule, determined from the various shades of colour which the liquid acquires during the process. Generally speaking, the colour of the juice while in the *haus* is natural; in *nikhár* whitish green, the whiteness being due to the colour of the slowly-rising scum; in *khaulá* pale yellow; in *phadká* yellow, and in *parchhá* golden yellow. The temperature of the *parchhá*, which is nearest to the feeding point of the

furnace, is always the highest, and great care is usually exercised in manipulating the liquid while it is in that pan so as to prevent its getting overheated or burnt. The slightest oversight or carelessness on the part of the *kárigar* when attending to this pan mars the quality of *ráb*, and such occurrences are not uncommon. From the *parchhá* the hot liquid is carried into the *nánd* through the channel called *parnáli*, and stirred in the latter by the *dori* in order to cool and develop the crystals. From the first *nánd* the material is transferred to the second, and from the second to the third, being stirred similarly in each. In some *bels* there are only two *nánds*. From the last *nánd* the liquid is poured into *karsis*, in which it cools finally and assumes the form of raw sugar that is popularly known by the name of *ráb*.

The juice separated from the *patoi* which is collected in the *nánd* below the *tipái* is taken out and converted in some *bels* into *shíra* by boiling; in others it is mixed with the boiling juice and converted into *ráb*, but this plan is said to injure the quality of *ráb*. In places it is customary to boil it separately in the third pan so as to convert it into *ráb* which, as a matter of fact, is of a comparatively inferior quality. The scum proper is of no use except for feeding cattle.

The staff required for working the "bel."—The owner of a *bel* has ordinarily to engage the following staff for the period the *bel* is worked, which generally extends over 3 to 3½ months ending with the *Holi* festival:—

| Designation. | Wages. | Duties. |
|--------------------------------|--|--|
| (1) <i>Munshi</i> ... | Rs. 5 to Rs. 7 a month ... | Keeps an account of juice received from the cultivators and of the <i>karsis</i> of <i>ráb</i> prepared. He is also general superintendent of the <i>bel</i> . |
| (2) <i>Daroghá</i> ... | Rs. 4 to Rs. 5 a month ... | Sees if everything is in working order and being properly used; also wakes at night to keep a watch over the <i>bel</i> stock. |
| (3) <i>Bhishti</i> ... | Rs. 1-8-0 per mill working for the <i>bel</i> . | Brings the juice from <i>matás</i> , pours it into the <i>hauz</i> , and reports to <i>Munshi</i> his having done so. |
| (4) <i>Jhoká</i> (the feeder). | Rs. 3 to Rs. 4-8-0 a month, | Three to five <i>jhokás</i> are kept in a <i>bel</i> to feed the furnace and to do miscellaneous work. |
| (5) <i>Kárigars</i> ... | Rs. 40 to Rs. 55 on contract for the whole season. | These are the men who boil the juice to prepare <i>ráb</i> and are held responsible for it, i.e., from the moment the juice is poured into the <i>hauz</i> till the <i>ráb</i> is carried to the last <i>nánd</i> for cooling. |

In addition to the wages noted above, the *Munshi* gets a *karsi* of *ráb* at the close of operations, and the *jhokás* are allowed some juice daily to drink.

The "bel" accounts.—The following is a carefully-prepared estimate of the expenditure and income of a typical *bel* in Rohilkhand in which 4,000 maunds of juice are worked into *ráb* during the season, juice being bought from cultivators under the *dádni* system in which money is advanced to the cultivators beforehand:—

| (a) Expenditure— | Rs. | a. | p. |
|---|-----|-------|-----|
| Four thousand maunds (standard) of juice at Rs. 45 per hundred maunds | ... | 1,800 | 0 0 |
| Erection of the <i>bel</i> building | ... | 22 | 0 0 |
| Hire of pans | ... | 45 | 0 0 |
| <i>Kárigars</i> engaged on contract for the season | ... | 46 | 0 0 |

| | | |
|--|-----|------------|
| Wages of a <i>Munshi</i> for 3½ months at Rs. 7 per mensem | ... | Rs. a. p. |
| " <i>daroghá</i> for 3½ months at Rs. 5 per mensem | ... | 24 8 0 |
| <i>Bhishti</i> ... | ... | 17 8 0 |
| <i>Jhokás</i> ... | ... | 18 0 0 |
| <i>Zamindár's</i> dues | ... | 44 0 0 |
| <i>Prohit</i> (priest) | ... | 15 0 0 |
| Alms to <i>Bráhmans</i> | ... | 2 0 0 |
| Mustard oil for clarifying juice | ... | 2 8 0 |
| Castor seeds | ... | 3 0 0 |
| <i>Deulá</i> (<i>hybiscus</i>) stalks | ... | 5 0 0 |
| Crude carbonate of soda (<i>sajji</i>) | ... | 5 0 0 |
| Fuel | ... | 12 0 0 |
| Stationery | ... | 49 0 0 |
| Contingencies (tobacco, mats, &c.) | ... | 0 12 0 |
| <i>Karsis</i> , 1,600, at Rs. 3 per hundred (to contain 20 seers of <i>ráb</i> on the average) | ... | 5 0 0 |
| Cloth for filters | ... | 48 0 0 |
| | ... | 2 8 0 |
| Total expenditure | ... | 2,166 12 0 |
| (b) Income— | | |
| Price of 800 maunds of <i>ráb</i> produced (20 per cent. of the juice) at Rs. 3 per maund | ... | 2,400 0 0 |
| Profit | ... | 233 4 0 |

The profit does not include interest on capital, which has been omitted in view of the fact that, under the *dádni* system, the proprietor of the *bel* gets juice at a much cheaper rate than if he were to make cash payment at the time of purchase, i.e. under the "*khush-kharíd*" system.

We also subjoin a statement showing the real accounts of three *bel*-working *khandsáris* of Sháhjahánpur in a number of years, the entries having been tallied up from their *bahi-khátas* under our personal supervision:—

Statement showing the real accounts of certain "*bel*" owners in the Sháhjahánpur district.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|-----------------------------|----------|-------------------------|-----------------|----------------------------------|--------------------------------|---------------------------|--------------------------------|------------------------------------|---|--|
| Name of <i>khand-sári</i> . | Year. | Weight of juice boiled. | Price of juice. | Cost of working the <i>bel</i> . | Price of juice per 100 maunds. | Total of columns 4 and 5. | Weight of <i>ráb</i> produced. | Percentage of <i>ráb</i> in juice. | Cost of producing one maund of <i>ráb</i> . | Cost of converting 100 maunds of juice into <i>ráb</i> . |
| | | Mds. | Rs. | Rts. | Rs. a. p. | Rs. | Mds. | | Rs. a. p. | Rs. a. p. |
| K. L. ... | *1894-95 | 3,845 | 1,731 | 261 | 45 8 3 | 1,992 | 723 | 18·8 | 2 12 1 | 6 12 7 |
| | 1897-98 | 4,923 | 3,028 | 312 | 61 8 1 | 3,340 | 1,088 | 22·1 | 3 1 1 | 6 5 4 |
| B. P. ... | *1894-95 | 3,601 | 1,656 | 426 | 45 15 9 | 2,082 | 680 | 18·8 | 3 0 11 | 11 13 3 |
| | 1895-96 | 6,079 | 3,112 | 335 | 51 3 1 | 3,447 | 1,155 | 18·9 | 2 15 9 | 5 8 5 |
| | *1896-97 | 3,485 | 1,462 | 350 | 41 15 2 | 1,812 | 686 | 19·6 | 2 10 3 | 10 0 8 |
| | 1897-98 | 2,822 | 1,736 | 220 | 61 8 3 | 1,956 | 526 | 18·6 | 3 11 6 | 7 12 9 |
| H. K. ... | 1898-99 | 5,262 | 2,743 | 302 | 52 2 0 | 3,045 | 1,048 | 19·9 | 2 12 11 | 5 11 9 |

* In this year extra expenditure was incurred in procuring the juice through paid contractors; hence the incidence of cost of conversion shown in column 11 was very high.

(3) *Dhosá*.

This is a product intermediate between *gur* and *ráb*, *i.e.*, thinner in consistency than the former and thicker than the latter. In its manufacture the juice is neither filtered nor clarified, and is full of all sorts of impurities. *Dhosá* is consequently very dirty stuff and is used exclusively for refining, never for eating on account of its repulsive appearance. It is largely manufactured in Azamgarh to be refined into *chíni*.

(4) *Shakar-i-surkh*.

Shakar-i-surkh is a form of raw sugar largely manufactured in the Meerut Division and parts of Rohilkhand direct from the cane juice and consumed by the middle and poorer classes as an article of food and used by the *halwáis* for the manufacture of inferior kinds of sweets. It is never used for refining, as it cannot be refined by any of the various systems of refining known to the native refiners and confectioners.

In the process of manufacture two pans are generally used. In the first the juice only simmers and is cleared of the scum which rises to the surface. It is then transferred to the next pan to be boiled completely, some liquid clarifying mixture being poured into it every now and then. As soon as the first pan is emptied of the hot juice, plain water is poured into it and the pan allowed to stand on the furnace. When the syrup has boiled down to a thick consistency, it is kneaded with the *dohri* in the pan, the heat in the furnace being lowered so that the contents of the pan may not burn. Should the syrup get overheated, hot water is poured into it from the adjacent pan. In the manufacture of *shakar* the boiling is continued a little longer than is done in the case of *gur*.

The boiled syrup is then removed to a *chák* (Figure No. 22) (a shallow, circular earthen vessel) and left there to cool partially. After an interval of about 30 minutes it is well stirred with the "*chatuá*" or "*háthi chák*," and as it thickens is made into a big lump of conical shape in the centre of the *chák*.

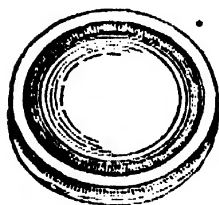


FIG. 22.



FIG. 23.

Háthi chák is a wooden implement resembling the mason's "*thápi*," to the flat end of which a piece of sheet iron is rivetted with nails (see Figure No. 23). *Reh*, the well known efflorescent salt found on the surface of *úsar* (alkaline) soils, is then sprinkled over the big lump and the mass is again kneaded with the *háthi chák* until it has acquired a pale yellow colour. The material is again made into a conical lump and removed to the next *chák* known as "*chakli*" to cool down further. In the *chakli* there remains always a certain quantity of *shakar* of the previous manufacture, which is technically called "*lapetá*." The conical lump is thoroughly smeared with the *lapetá*, the operation being known as "*lapetá dená*." It is stated that this coating of the "*lapetá*" stops evaporation and free escape of the gas formed by the action of the *reh* (alkali) on the organic acids present in the juice,

and facilitates the crumbling of the mass into a fine powder. After 15 or 20 minutes the mass is rubbed violently between the hands till the *sukh shakar* is ready.

We carried out two experiments in a cultivator's boiling shed in Muzaffarnagar, to determine how far the use of *reh* and *lapetá* were necessary or advantageous. In the first experiment no *lapetá* was added to the mass and a moderate quantity of *reh* was mixed with it. The mass could be broken to a powder, but it required considerable manual force, and a large number of small lumps (*turri*) of *gur* were, moreover, left uncrumbled. In the second experiment, in which only "*lapetá*" was used and no *reh*, it could easily be reduced to a fine powder with very little *turri* in it. The product of the first experiment was, however, superior to that of the second in respect of colour.

It can therefore be safely stated that the *reh* greatly improves the colour, while the use of "*lapetá*" materially helps the crumbling. The presence of "*turri*" (small unbroken lumps) in the *shakar* is an undesirable feature, and reduces the market value of the "*shakar*." In 12 hours six or seven *kundis* of juice can be boiled and made into *shakar*, each *kundi* containing about 3½ standard maunds of juice.

Juice sufficient to produce 100 maunds of "*gur*" yields about 98 maunds of "*shakar*." *Shakar* has the objectionable property of deliquescence when exposed to the air in the rainy season, and this is one of the reasons why it is not more in favour with the public.

(5) *Khánd* or *shakar* of the east.

A product of *ráb* almost identical with the *potli* of Rohilkhand is known in eastern districts under the name of *khánd* or *shakar*; but the methods of manufacture of the two articles differ. The following is an account of the method of manufacturing *khánd* or *shakar* borrowed from the Settlement Report of Azamgarh:—

"To make *shakar* a series of little parallel drains are made in the floor of one end of a small house or closet. These drains are from one foot to 18 inches apart, and are six or seven inches deep and broad. They lead into a somewhat larger drain, which cuts them at right angles and leads into a *dobhá*. Over the floor thus divided by "*nális*" a framework of bamboos called *dhár* is laid, and upon that a matting made of rushes or *gondri*. The *ráb* is tied lightly in cloth (*lothá*) in quantities of a maund. The bundle is called a *motari*, and when allowed to take shape, it is a round, flattish mass like a large cheese. Several *motaris* are piled one above another in rows upon the *dhár* over the drains, and large weights made of sun-baked clay, called *bhirás*, are put upon the piles. *Chotá* soon begins to ooze from the *motaris*, and to trickle down through the *dhár* into the *nális* and *dobhá*. Compression is kept up probably for 15 or 20 days till *chotá* ceases to exude. The stuff which remains in the *motaris* is *shakar*, and it is a damp, light brown substance. One-half (in weight) of the *ráb* should remain as *shakar*, and in the manufacture of *chíni* from it there should be little or no refuse.

One-half (in weight) of the *shakar* becomes *chîni*, the other half is molasses. *Shakar* sells at about half the price of *chîni*."

CHAPTER VII.

CEREMONIES AND SUPERSTITIONS CONNECTED WITH THE CULTIVATION OF SUGARCANE.

It would indeed be strange if in a country like India the cultivation of such an important crop as sugarcane were not attended with some ceremonies and superstitious observations. These are numerous and are connected with most of the intermediate processes of cane cultivation, by far the most general and prominent being those observed at the times of sowing and cutting the crop.

Since agriculture as a profession is mostly confined to the Hindus in these Provinces, these ceremonies and superstitions are necessarily Hinduistic in their form and conception. But, wherever Muhammadans follow the agricultural profession, they also not uncommonly observe them like their Hindu brother-cultivators. Any complete survey of the subject is out of the question; but in the following pages an attempt will be made to discuss it very briefly.

The ceremonies which belong to each process will, so far as possible, be described under that heading.

Sowing.

Throughout the United Provinces it is the common practice to make some *pujâ* in the field to be sown with cane on the day of sowing and to give a feast to friends and Bráhmans, which latter ceremony is generally called "*ukh bhoj*." The object, no doubt, is the invocation of Divine aid for success in the enterprise. This practice is common; but the details are varied in their form in the different parts of the Provinces, and it will be interesting to note them here.

The following custom, with slight local diversities in details, is observed at the sowing time in the Agra and Rohilkhand Divisions, in Bundelkhand, and in Oudh.

On the day of sowing the plough is first taken to the field amidst a procession of females singing *bhajans* (hymns) all the way from the cultivator's house to the field. Arriving at the field, five small sticks are fixed in a corner of the field, and within the enclosure formed by these sticks the sacred fire, *agyâri*, is kindled. Some sweets, *dhâp* (a kind of resin), and rice are then offered at the fire. This being over, the time comes for the plough to commence sowing. The ploughman wears a *hanuli* (necklace) round his neck and has a *tikâ* (mark) painted on his forehead with the sacred red dye known as "*roli*" or "*rori*." The bullocks yoked to the plough have also a *tikâ* put on their foreheads. *Kâial* (soot obtained from a common country lamp) is dusted into the eyes of both the driver and the bullocks.

Mr. Moens, in his Settlement Report of the Bareilly District, thus describes the custom prevailing in that district at the time of sowing :—

“An ordinary plough which has first been *pujad* and had a red *tiká* put on it goes first; this is followed in the same furrow by a second. Behind this comes the sower wearing silver ornaments, a necklace (*hansli*) and flowers on his neck and a red *tiká* on his forehead. He is usually fed with *ghí*, *míthái*, &c., before commencing After the sowing is completed all who have been engaged in the work come to the house of the cultivator of the field and have a good dinner of *karhi* (a dish made of gram flour and curdled milk), rice, *dál*, and *chapátis*.”

. In Gorakhpur, when the field is ready to receive the seed, a pitcher full of water is first placed in it. The driver then takes the plough and moves it either to the east or to the north. When the seed is first thrown into the field, the cultivators invoke the blessings of their household gods by crying out “*Jai jai!*” Then in the evening follows the inevitable feast. The same night, after the feast, the women and children of the family take to the field some victuals, such as rice, milk, &c.; they are accompanied by a labourer who has on his head a basketful of manure. The manure is spread on the field and the plate containing the victuals placed on it; around the plate five, seven, or nine *sarkandás* (reeds) are fixed in the manure, to which the party make obeisance. A *chirágh* (lamp) is then lit, and the *káíal* (soot) obtained from it is applied to the eyelashes by all present and the following couplet is sung in a chorus :—

“*Shiva máli, Shiva máli, khaó dúdh bhát :*

Ukhiá upjai náu náu háth.”

[O! Shiva, the gardener, eat rice and milk (and we pray that)
Sugarcane may grow as tall as nine cubits.]

Some more prayers are then offered and the party return home.

The fixing of the *sarkandás* and the dusting of *káíal* are auguries of the tall growth of the cane crop and black colour of the bloom of the canes.

As to the superstitions connected with sowing—

- (a) the sight of a man on horseback at the time when cane is being sown is regarded a good omen;
- (b) similarly the sight, at the time, of a horse loaded with cane is also regarded auspicious;
- (c) in Ballia the cultivators abstain from using salt in their food on the day of sowing for fear the juice may become saltish in taste;
- (d) in places females are not allowed to cross the sugarcane fields in the early stages of its growth, because it is supposed that the presence of the weaker sex at such a time would render the crop poor.

Disease.

To avert disease the cultivators in Sháhjahánpur make a *pújá* on the 18th of *Baisákh*. It is called the *Bahadurá-ká-pújá*, as it is done to propitiate the

bahadurá, an insect injurious to the crop. According to Mr. Moens, a similar ceremony, known as *Sunri-ká-pujá*, is observed in Bareilly in the month of *Kátik*, to ward off the insect called *sunri*.

“The *asámi* takes from his house *púris*, *ghí*, *míthái*, and five or six *sunris* of *átá* (wheat flour) pressed into the shape of a pear and some clean water, goes to the field, and burns a *hóm* and sacrifices some of the *púris*, &c. He then buries one of the *sunris* at each corner of the field, eats the remainder of the *púris*, &c., and goes home happy.”

Cutting.

There is a custom among cultivators having well nigh the force of law not to cut the cane crop before the *Deo-othán* (the 11th day of the second half of *Kátik*). The custom must have been very rigidly followed in former times; but at the present day some laxity in its observance is noticeable, as canes for chewing purposes come long before the *Deo-othán* into the markets of the larger cities in these Provinces. The greater part of the cultivators who thus bring their produce to the market before the fixed date are Muhammadans, who do not follow the Hindu cultivators in this respect, and to this is probably due the early cutting of the chewing cane in the neighbourhood of larger cities. It is, however, remarkable that the cane cut before the date above specified is used only for chewing, and not for pressing. An orthodox Hindu can, nevertheless, on no account be persuaded to eat sugarcane before the *Deo-othán*. This custom has naturally associated the celebration of *Deo-othán* with the cultivation of sugarcane, although in reality *Deo-othán* is a festival quite independent of the cultivation of cane. It is therefore erroneous to suppose that *Deo-othán* is a cane cultivation festival, as some people seem to think. It is the day on which, according to Hindu belief, the god Vishnu rises from his four months' sleep. He is worshipped that day, and among several other articles sugarcane is also offered to him. On the *Deo-othán*, before cutting of the crop is commenced, the following ceremony is observed:—

The cultivator first breaks off a number of canes and distributes five canes each to the village priest, blacksmith, carpenter, and *dhobi*, and takes five canes to his house for purposes of the *pujá*, where he offers them to Vishnu with prayers and certain other rites. The *mantrá* read by the Bráhman priest in the *Deo-othán* *pujá* runs as follows:—

उत्तिष्ठोतिष्ठ गोविन्द त्यजनिद्रां जगत्पते ।

त्वयि सुप्ते जगत्सुप्तं मुत्थिते चात्थिं जगत् ॥

[Rise and sit up, O Lord! shake off Thy slumber, O Master of the Universe! With Thee hath slept the whole of the universe, and with Thy rising shall it rise.]

In places the tops of the canes are broken off when the *pujá* is over and suspended to the roof till the *Holi*, when they are burnt. The canes used for *pujá*

are given to the family priest. After this *pujá* the cutting of the crop commences from the time fixed by the priest as propitious for the operation.

Whatever may be the other objects held in view in fixing the cutting of cane on the day of *Deo-othán*, one thing is certain, and it is the fact that till then the sugarcane is unripe, the juice not fit for boiling, and the cane not worth eating.

Extraction of the juice.

The extraction of juice is commenced on the day and hour fixed by the Bráhmaṇ as lucky for the cultivator. Some of the juice is first given to a Bráhmaṇ, and is also distributed to friends of the family and the labourers employed in the work. In some districts friends are also feasted at night, the meal served consisting chiefly of rice boiled in the juice.

In Gorakhpur the pressing of canes is commenced before *kharváṇs* (an inauspicious period prescribed by astrologers), and if circumstances do not permit this, then the pressing is deferred till that period is over. When the work commences after the *kharváṇs*, the juice pressed first is eaten by the cultivator and his friends and not used for *gur*-making, the practice being called *kharjar* (destroyer of bad luck).

In Basti from the first produce of the *kolhu* (sugar-pressing mill) offerings are made to *Mahákáli* and *Mahádeva*.

In Bijnor, near the furnace for boiling the juice, "the tomb of a *kázi* (judge)" is erected, and before making *gur* some juice is poured on it. When the *gur* is made, a small quantity of it is offered daily at the tomb. The belief is that the departed souls of the pious *kázis* who administered justice in former times will, if thus propitiated, shower blessings and make the operation a successful one.

Gur-making.

According to the usual practice of the Hindus, the lump of *gur* made first is given to a Bráhmaṇ for eating, and is also distributed among the labourers employed in the process. There are some variations in this practice of course in places. For instance, in Basti, when the *gur* is ready one seer and a quarter of it is set apart for offering to Mahábir or Hanumán, the monkey god, and is as far as possible sent to the great temple of that god at Ajudhyá. Failing this, it is given over to a Bráhmaṇ by way of charity.

The Bhaṇṇarau ceremony.

Before the manufacture of *gur* or *ráb* commences regularly in the eastern districts, the cultivators who join in one *kolhu* for the crushing season cut a bundle of canes from their respective fields and carry them to the pressing machine at an auspicious hour of the day fixed by the village priest. The canes are pressed, the juice is boiled and made into small *bhelis*, each weighing about two *chhatáks*.

The *bhelis* known as *Bhaṇṇarau-ki-bheli* are distributed among themselves and also given to the menials of the village and the priest: On the day following the ceremony the regular manufacture of *gur* or *ráb* begins.

This ceremony is observed among the cultivators of the eastern districts only, and is known as *bhaṅṅarau*.

On the last day of cane-crushing the cultivators in the western tracts leave one or two clumps of canes in their fields in honour of *makāl deotā*, who is believed to have brought canes into the world.

It is stated among the Hindu cultivators that once upon a time, at a certain place where cane-crushing was going on, the *muthiā*, or the man who feeds the crushing machine, finding no canes, cried out to *makāl deotā*, who was standing by the *kolhu* without being recognised by anyone, to bring canes to him. Upon this *makāl deotā* ran away as fast as he could to the cane field lest he might be forcibly employed as a labourer. Since then *makāl deotā* is supposed to keep himself hidden in the cane fields and never goes to the mills. His share of canes is therefore left at his abode, and these canes are either taken away by the poor class of people or allowed to dry on the spot.

To assume that what has been said above is a complete description of all the ceremonies connected with the cultivation of sugarcane would be misleading. There are so many minor ceremonies performed, and they differ so much from place to place and even among the cultivators of the same village, that to describe them in detail would be a lengthy work. Besides, such a description is beyond the scope of this manual.

Only important and extensively common ceremonies have therefore been mentioned here.

CHAPTER VIII.

SEMI-REFINED SUGARS.

Method of manufacturing "sewāri shakar" as practised in the Basti district.

Rāb is first thrown into a masonry tank, at the bottom of which bricks are placed two inches apart from each other. A mat is then spread over the bricks. The treacle filtering through the mat passes out through a hole in the wall of the tank, to accumulate in an adjoining pit, "*dānā*" (drained raw sugar) being left on the mat. This operation occupies four or five days, and then the *dānā* is removed to a set of *nānds*, each having a hole at the bottom. These *nānds* are placed on small pillars in such a manner that the syrup trickling through the hole may drop into an earthen vessel (*handiā*) placed underneath.

A layer of *sewār* weed (*Hydrilla verticillata*) three inches thick is spread over the raw sugar kept in each *nānd*. After four or five days it is folded up and the brown sugar (*pachhni*) is scraped off from the surface. The *dānā* is again covered over with a fresh layer of *sewār*, over which the one used before is also spread. The scraping is done after every four days until the syrup (*shirā*) is completely drained off. The *pachhni* thus obtained is called *sewāri shakar* and is used by *halwāis* in the manufacture of sweets. If it is to be kept long, it

is exposed to the sun and trodden under feet like *kachchi chīni*; but the product is very poor in colour, though the crystals are large. *Sewāri shakar* is generally sold at $4\frac{1}{2}$ to 5 seers a rupee.

• The *pachchni* scraped at the bottom of the *haudā*, being inferior in quality, is used only for making *gattā*, and is known as *taraunchā*.

The syrup drained from the *haudā* through the hole is called *chotā* and used in the manufacture of native tobacco mixtures and country spirits, and is also utilized as a drink. It is generally sold at R. 1-4-0 a maund. Eleven maunds of *rāb* will produce about six maunds of *sewāri shakar* and five maunds of *chotā*.

• The “*darrā*” and “*uthauwā*” of the Fyzabad district.

• These are the same as the *sewāri shakar* and *taraunchā* of the Basti district respectively: only there is a slight difference in the method of manufacturing them, and the appliances used.

• In Fyzabad the *rāb* is brought in leather jars (*kuppās*) in which the *dānā* settles down while the *shirā* floats on the surface. The *dānā* is taken out and thrown into a vat made of mats instead of in *nānds* used in the Basti district, and is left for a fortnight in the vat. When the syrup is drained off, the mass in the vat is covered over with *sewār* and the same process followed as in the case of *sewāri shakar* in Basti.

The *pachchni* obtained is trodden under foot in sunshine, not under the shade, and is known as *darrā*.

Successive layers of *pachchni* are scraped off every third day and treated in the above manner.

The *pachchni* scraped off the lower portion of the *dānā* near the bottom and treated likewise is known as *uthauwā*.

The *uthauwā* is inferior to *darrā* in respect of crystals and colour.

CHAPTER IX.

REFINED SUGARS.

Method of manufacturing “kachchi chīni” or “khānd” as practised in the Rohilkhand Division.

• EARTHEN-pots (*kalsis*) (Figure No. 24), filled with *rāb*, are carted to the
FIG. 24. factory, and stored till required for use.



To make the refined sugar “*khānd*” a number of these “*kalsis*” are removed and placed close to the oblong masonry tank known as “*latauri*” or “*channi*,” which is generally about $13\frac{1}{2}$ feet long by four feet wide by three feet deep. The tank is always constructed above ground, and its dimensions vary according as the factory is worked on a large or small scale.

At the bottom of the tank bamboos are laid lengthwise $1\frac{1}{2}$ feet apart, and over them dry stalks of the reed grass (*senthá*) or cotton (*kapsethi* or *benoti*) are placed crosswise. This framework is covered with blankets fastened to the walls by means of wooden pegs. The *kalsis* are, one by one, struck against the walls of the "*channi*" in order to break them, and the contents are then emptied into the tank.

This operation continues until the tank is filled with the "*ráb*." The fragments of the "*kalsis*" are scraped with an iron spoon and the scrapings thrown into the tank. The pieces are either thrown away or washed and the washings (*sharbat*) sold off for a trifling sum. Quite close to the wall of the "*lalaúri*" an earthen pot (*matká*) is sunk into the ground, into which the syrup filtering slowly through the blanket, accumulates, there being an escape channel for the syrup at the bottom of the *lalaúri*.

When the *matká* is quite full, its contents are removed to the "*nánd*," a large masonry reservoir similar in shape to the "*chah bachchá*" described under *pakki cháni*.

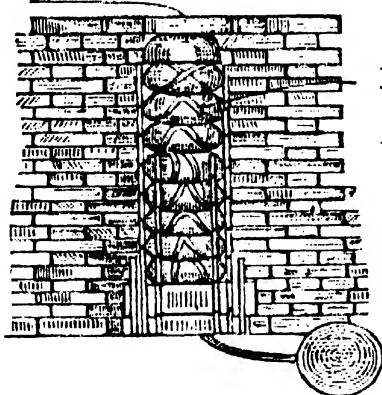
Next morning the drained *ráb* is packed in bags $1\frac{3}{4}$ feet long by $1\frac{1}{2}$ feet broad, called *ará* or *bojhá*, which are made of blanket cloth.

In front of the *lalaúri* and within a few yards of it, there is a series of masonry pits, also known as *ará*, each about 27 inches square, and having about the same depth. At the bottom of each pit bricks are placed at a little distance

FIG. 25.

Bhirá.

Wall.



Bags.

Wall.

from each other, and bamboos are then laid across each pit over the bricks.

A wooden plank (Figure No. 25) stands vertically against the wall to serve as a support for the bags.

A dozen bags (Figure No. 25) are then put in each pit, one over the other, and are firmly tied with strings to a number of thin bamboo sticks standing against the walls of each pit, so that the bags may always keep in position.

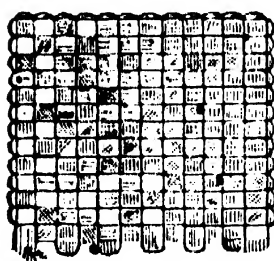
They are subjected to the pressure of weights, *bhirá* (Figure No. 25), over which a man stands holding a stick in his hand and moves his body backward and forward all day long, in order to squeeze out the syrup as much as possible. After six hours of squeezing the bags are opened and their contents rubbed between the hands. They are then tied up again and pressed in the manner just mentioned. This process is known as *dobandi*.

The syrup, draining off through a channel, is collected in an earthen vessel sunk in the ground (*mandiá*), whence it is removed to the *nánd*. Next morning the bags are emptied of their contents, which are now called *potri*, *putri*, or *potli*.

The latter is removed to the next room, where it is thrown into a receptacle called "*khānchi*."

To make the *khānchi* wooden pegs, each four feet long, are driven into the ground about $1\frac{1}{2}$ feet apart along the side of the walls of the room. *Tattis* made of reed grass are erected around these pegs to serve as the walls of the *khānchi*. A mat (Figure No. 26) made of *pateri* stalks (an aquatic plant) is made to stand against the *tattis*.

FIG. 26.



If the room is spacious enough, the *khānchi* is divided into two compartments by means of *tattis* made of the same material and erected in the middle.

At the bottom of the *khānchi* bricks are placed at a little distance apart.

Over the bricks bamboos are first laid lengthwise, three feet apart, and over these a number of bamboos are again placed crosswise, nine inches apart, so as to form a sort of network, to allow free passage to the syrup downwards. The bamboos are tied firmly with strings at the points of intersection. Dry stalks of reed grass are placed about three inches thick on the framework, over which pieces of coarse cloth known as *pāl* are spread.

The *khānchi* thus made is similar to the *khātā* described under *pakki chini*.

When the *khānchi* is filled with the *putri*, its surface is levelled with a round brass vessel (*thālī*) and covered over with a layer of *sewār* about an inch thick. This layer is rolled up after three days and replaced by a fresh layer of the weed, over which the old layer is again spread.

When the surface of the mass treated with the weed has been sufficiently decolourized, it is scraped off with an iron tool called

FIG. 26A.



"*karchhulā*" (Figure No. 26A) to a depth of six inches, where the *sewār* has not yet fully exercised its absorbent action. The scrapings constitute the product known as "*pachhni*." A fresh layer of the *sewār* is then placed in the "*khānchi*" and the *pachhni* removed to be spread out on a *tāt* and trodden down till the sugar becomes quite white.

It is now called *khānd* and is packed in bags for sale.

When the "*khānchi*" is emptied of about half its contents, the old layers of *sewār* which accumulate at the top are all thrown away to make room for the new ones which are successively applied. It takes from 25 to 30 days to convert all the *putri* of a tank of such dimensions as has been described above into *khānd*.

The syrup filtering through the passages provided in the *khānchi* accumulates in the *matkās* sunk into the ground, and is subsequently removed to a reservoir.

This product is known as *galāwat* or *kachāwat*.

The *galawat* is reboiled into *ráb*, which, under the process just described, is again refined into an inferior quality of *khánd* known as *galawat-ki-khánd*. The upper part of the mass in a "*kháñchi*" yields, as a rule, a superior quality of refined sugar, which is known as *rás* or *phul*; the middle portion gives a somewhat inferior stuff called *adhautá*, and the lower portion produces a sugar still inferior in respect of colour and crystals, which is called "*taraunchá*," and corresponds to the secondary product "*domá*" obtained in the manufacture of the *pakki chini*.

The *rás*, the *adhautá*, and the *taraunchá* are not uncommonly mixed together, the mixture being known as "*kharál*" or "*khal*." If the material to be refined is *bel ráb*, a *kháñchi* containing enough to produce 16 maunds of sugar will yield eight maunds of *phul*, four of *adhautá*, and four of *taraunchá*.

In case of *sáir ráb* the ratio of these products will be as 4 : 8 : 2 respectively.

The syrup eliminated from *ráb* in the tank (*laláñri*) and in the *ará* is known as "*bandhui-ká-shirá*." It is boiled and manufactured into *bheli*, a form of *gur* which is not, however, fit for refining.

Method of manufacturing "kachchi chini" as practised in the eastern districts, especially in Jaunpur.

Kachchi chini is a product of *ráb* very similar, though inferior, to the *khánd* of Rohilkhand, and is manufactured in eastern districts by cultivators or *halwáis*, seldom by *khandsáris*. There are two systems of manufacture, viz., the *khátá* system and the *haudá* system. We shall describe these separately.

I.—The *khátá* system.

To manufacture *kachchi chini* under this system, a tank about $6\frac{1}{2}$ feet long by $2\frac{1}{2}$ feet broad by 2 feet deep known as *khátá*, is made either of *kachchá* or *pakká* bricks, the inner walls of the tank being plastered over with mud. The tank is always constructed above the ground. The number of tanks in a factory varies with the extent of the refiner's business. Quite close to the wall of the *khátá* an earthen vessel, known as *dobhá*, is sunk into the ground and a channel is made through the wall to allow the syrup to pass into the *dobhá*.

Three pieces of bamboos, called *phalthá*, are laid longitudinally at the bottom of the tank over which *mutthás*—long and thin bundles of *sarpát* grass (*Saccharum ciliare*)—are placed crosswise. Mats made of rice straw are also spread over this framework.

Ráb is transferred from *haudá*, wherein it is first collected, into the *khátá* thus constructed, and left there for six to eight days, during which period a portion of the uncrystallizable syrup (*chotá*) filters through the framework and accumulates in the *dobhá*.

When the *dobhá* is quite full the *chotá* is removed to some other vessel. The *ráb* in the *khátá*, now called *shakar* is then covered over with a layer of the *sewár* weed about an inch thick. On the third day the layer of *sewár* is folded

up and replaced by a fresh layer, over which the old layer used before is unfolded.

After six days a white layer, known as *parchhani*, about half inch thick, appearing on the surface of the mass is scraped off with a "*sutuhá*" and kept separately in a *nánd*. The mass is again covered over with a fresh layer of wood as before.

FIG. 27.



FIG. 28.



When about a maund of *parchhani* has been collected, it is taken in small quantities and kneaded with hands in a small, round wooden vessel known as *ayhiyá* (Figure No. 27), a little water being sprinkled over it. It is then put in a bag (*lothá*) made of a piece of coarse cloth, the bag being previously placed in a shallow, earthen *nánd* known as *tarchhá* (Figure No. 28). The mouth of the bag is tied firmly with a piece of string, and then the bag with its contents is known as *motri*. A *motri* contains about a maund of *parchhani*. The *motri* is then kept in a separate enclosure on pieces of bamboos and subjected to pressure of stone or mud weights known as *bharuá* for about a week. A *bharuá* weighs about two maunds. If two or three *motris* of sugar be ready at a time, they are placed one above the other and treated in the manner stated. During the period mentioned the syrup filtering slowly through the cloth accumulates in a *dobhá* sunk into the ground for the purpose. This syrup is known as *shirá*. When the syrup has been all got rid of, the *motri* is untied and emptied of its contents (*parchhani*). The portion of liquid sugar sticking to the surface of the *motri* when dry is known as *chopi*. It is scraped off with the *sutáhá* and collected in an earthen vessel. It is generally used in the refiner's kitchen and is never sold. The portion of sugar that still remains stuck to the cloth is technically called *kharuká*. To remove it the cloth is dipped in water and the sugar dissolved by rubbing and squeezing the cloth. The solution is chiefly used as a drink, or it may be boiled down to make a syrup.

The *parchhani* is spread on a piece of *tát* known as *pátá*, and is trodden down by the feet for eight hours till the sugar becomes quite white. One man can tread two *motris* of *parchhani* during this period. The white sugar thus obtained is called *kachchi chíni*. It has a molassy flavour about it, and is therefore used almost entirely for the manufacture of *misri*, *batásá*, and other sweetmeats, in which it undergoes a further process of refining with milk. *Kachchi chíni* can scarcely be regarded as an article of commerce.

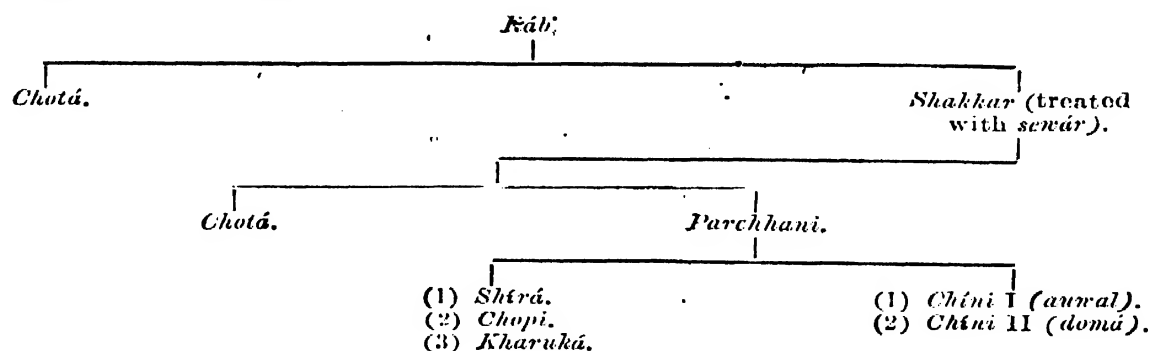
When a westerly wind is blowing, the *parchhani* takes about two hours less of treading and yields a better colour of sugar than when the wind is easterly.

Successive layers of *parchhani* are scraped and treated in the manner described above until the *khátá* is nearly emptied. The *parchhani* left at the bottom of the tank about two inches thick is scraped off and treated separately in the manner just described. It produces an inferior quality of sugar known as *kachchi chíni domá*. The *shirá* which accumulates in the *dobhá* near the *khátá* is known as *chotá*, and is used in making inferior sweets like *guttá*, *reori*, and *patti*.

One hundred maunds of *ráb* of the first quality will give the following products under the *khátá* system :—

| | | | | | | Maunds. |
|------------------------------------|-----|-----|-----|-----|-----|---------|
| <i>Kachchi chíni</i> , first class | ... | ... | ... | ... | ... | 30·00 |
| " second class | ... | ... | ... | ... | ... | 3·33 |
| <i>Chotá</i> ... | ... | ... | ... | ... | ... | 55·00 |
| <i>Shírá</i> ... | ... | ... | ... | ... | ... | 4·50 |
| <i>Chopi</i> ... | ... | ... | ... | ... | ... | 0·33 |
| <i>Kharuká</i> ... | ... | ... | ... | ... | ... | 1·25 |
| Loss ... | ... | ... | ... | ... | ... | 5·59 |
| Total | | | | | | 100·00 |

The following diagram will show more clearly the nature and detail of the products mentioned above :—



The following tables will show the profit and loss account during the first two years of a *halwái* who starts the business of *kachchi chíni* under the *khátá* system :—

List of articles required for manufacturing "*kachchi chíni*" from one hundred local maunds of "*ráb*" in Jaunpur (a local maund = 1·4125 standard maunds).

| FIRST YEAR'S EXPENDITURE. | | | | | | Price. | | |
|--|-----|-----|-----|-----|-----|--------|----|----|
| Name of article. | | | | | | Rs. | a. | p. |
| <i>Itáb</i> | ... | ... | ... | ... | ... | 400 | 0 | 0 |
| Cost of constructing a <i>khátá</i> or tank | ... | ... | ... | ... | ... | 2 | 8 | 0 |
| Twenty <i>haulás</i> | ... | ... | ... | ... | ... | 5 | 0 | 0 |
| Pay of two servants for three months, at Rs. 4 per mensem each | ... | ... | ... | ... | ... | 24 | 0 | 0 |
| Three <i>nánds</i> | ... | ... | ... | ... | ... | 0 | 6 | 0 |
| Cost of the <i>sewár</i> weed | ... | ... | ... | ... | ... | 4 | 0 | 0 |
| Coarse cloth for <i>lothá</i> | ... | ... | ... | ... | ... | 4 | 0 | 0 |
| <i>Khása</i> (the cloth which is used for lining the bags) | ... | ... | ... | ... | ... | 5 | 0 | 0 |
| Bamboos | ... | ... | ... | ... | ... | 0 | 4 | 0 |
| Six mats | ... | ... | ... | ... | ... | 0 | 1 | 6 |
| <i>Mutthás</i> made of <i>sarpat</i> grass | ... | ... | ... | ... | ... | 0 | 8 | 0 |
| <i>Satuká</i> (the iron scraper) | ... | ... | ... | ... | ... | 0 | 4 | 0 |
| <i>Turchhá</i> | ... | ... | ... | ... | ... | 0 | 2 | 0 |
| Small <i>dobhá</i> | ... | ... | ... | ... | ... | 0 | 0 | 6 |
| Large " | ... | ... | ... | ... | ... | 0 | 1 | 0 |
| Two <i>pátás</i> | ... | ... | ... | ... | ... | 6 | 0 | 0 |
| 20 bags | ... | ... | ... | ... | ... | 4 | 0 | 0 |
| Sieve | ... | ... | ... | ... | ... | 0 | 2 | 0 |

| Name of article. | Price. | | |
|--|--------|----|----|
| | Rs. | a. | p. |
| <i>Taulá</i> (the vessel for removing <i>ráb</i> from the <i>haudá</i> into the <i>khátá</i>) | 0 | 2 | 0 |
| Bamboo sticks for the treaders of <i>chíni</i> | 0 | 0 | 6 |
| Wooden shoes for the treaders | 0 | 2 | 0 |
| „ tray | 0 | 4 | 0 |
| Four <i>háydís</i> (earthen pots) | 0 | 1 | 0 |
| Total | 456 | 14 | 6 |

SECOND YEAR'S EXPENDITURE.

| Name of article. | Price | | |
|------------------------------|-------|----|----|
| | Rs. | a. | p. |
| <i>Ráb</i> | 400 | 0 | 0 |
| Wages of two servants | 21 | 0 | 0 |
| Cost of <i>sewár</i> | 4 | 0 | 0 |
| Mats | 0 | 1 | 6 |
| Total | 428 | 1 | 6 |

FIRST YEAR'S INCOME.

| Products. | Quantity. | | Rate. | Price. | | |
|--|-----------|----|---------------------|--------|----|----|
| | Mds. | s. | | Rs. | a. | p. |
| <i>Kachhi chíni</i> , first class | 30 | 0 | Rs. 11 per maund... | 330 | 0 | 0 |
| „ second class | 3 | 13 | „ 9 „ | 30 | 0 | 0 |
| <i>Chotá</i> | 55 | 0 | „ 2 „ | 110 | 0 | 0 |
| <i>Shírá</i> | 4 | 20 | „ 1 „ | 18 | 0 | 0 |
| Total income | | | | 488 | 0 | 0 |

PROFIT AND LOSS ACCOUNT OF THE FIRST YEAR.

| Total cost. | Total income. | Profit or loss. |
|-------------|---------------|-----------------|
| Rs. a. p. | Rs. a. p. | Rs. a. p. |
| 456 14 6 | 488 0 0 | +31 1 6 |

PROFIT AND LOSS ACCOUNT OF THE SECOND YEAR.

| Total cost. | Total income. | Profit or loss. |
|-------------|---------------|-----------------|
| Rs. a. p. | Rs. a. p. | Rs. a. p. |
| 428 1 6 | * 488 0 0 | +59 1 6 |

It will be seen from the above accounts that the profits of the manufacturer should increase successively as the appliances purchased in the first and second years will be utilized in the following years. The actual profits will, however, necessarily vary according to the prices of *ráb*, *chíni*, and molasses prevalent in each year.

II.—The *haudá* system.

The following account of the method of manufacture is based on the practice followed in Deogaon (Azamgarh) and Sháhganj (Jaunpur):—

In this system a *haudá* having a hole at the bottom is used in place of the *khátá* or tank. Pieces of bamboos are placed lengthwise and crosswise inside the

* The income of the second year has been put down at the same figure as that of the first, as the quantity of *ráb* used in both years is the same and the amount of the various products in both years has been assumed to be equal.

haudá, over which a piece of *tát* is spread, the bamboo structure being known as *thattar*. The *ráb* is then thrown into the *haudá* and left in it for three or four days. When the *chotá* has trickled down into a receptacle (*dobhá*) sunk below the *haudá*, the sugar in it is treated with the *sewár* weed in the manner described under the *khátá* system. The *parchhani* is also subsequently treated in the same manner.

Ráb is classified under three heads by the manufacturers of *kachchi chini* with reference to the quality. The best *ráb* is called *tiptá*, the one next in quality is known as *chauthiyá*, and the third is designated as *pachaiyán*. The outturn of the various products from 100 local maunds of *ráb* is stated to be as follows, according to the quality of the *ráb* :—

| Products. | From— | | |
|---|-----------------------------------|--|---------------------------------------|
| | <i>Tiptá ráb</i> (first quality). | <i>Chauthiyá ráb</i> (second quality). | <i>Pachaiyán ráb</i> (third quality). |
| | * Mds. | * Mds. | * Mds. |
| <i>Kachchi chini</i> , first class (<i>aural</i>) ... | 28.00 | 22.00 | 16.00 |
| second class (<i>domá</i>) ... | 5.33 | 3.00 | 4.00 |
| <i>Chotá</i> " ... | 62.00 | 70.00 | 74.50 |
| Loss ... | 4.67 | 5.00 | 5.50 |
| Total ... | 100.00 | 100.00 | 100.00 |

* One local maund = 1.4125 standard maunds.

A profit and loss account of the manufacture under this system is given below :—

FIRST YEAR'S ACCOUNT.

Expenditure.

| Name of article. | Price. |
|-------------------------|---------|
| Rs. a. p. | |
| <i>Ráb</i> ... | 400 0 0 |
| 32 <i>haudás</i> ... | 8 0 0 |
| 4 <i>náyd.</i> ... | 0 8 0 |
| Wages of two servants | 24 0 0 |
| Eight <i>matkás</i> ... | 0 2 0 |
| One <i>pátá</i> ... | 3 0 0 |
| Bamboo sticks | 0 0 3 |
| Two baskets | 0 2 0 |
| Sieve ... | 0 2 0 |
| <i>Thattar</i> ... | 0 8 0 |
| Total | 436 6 3 |

SECOND YEAR'S EXPENDITURE.

| Name of article. | Price. |
|-----------------------------|---------|
| Rs. a. p. | |
| <i>Ráb</i> ... | 400 0 0 |
| Wages of two servants | 24 0 0 |
| Price of <i>thattar</i> ... | 0 8 0 |
| Total | 424 8 0 |

| Products. | Quantity. | FIRST YEAR'S INCOME. | | | Price. |
|--|-----------|----------------------|-----|-------|-----------------------|
| | | Mds. | Rs. | a. p. | Rs. a. p. |
| <i>Kachchi ohtni</i> , first class ... | 28 | 11 | 6 | 0 | per maund ... 318 8 0 |
| second class ... | 5 | 8 | 0 | 0 | " ... 40 0 0 |
| <i>Chotá</i> ... | 62 | 1 | 12 | 0 | " ... 108 8 0 |
| Total income | | | | | ... 467 0 0 |

| PROFIT AND LOSS ACCOUNT OF THE FIRST YEAR. | | | Profit or loss. | | |
|--|---------------|--|-----------------|-------|----------|
| Total cost. | Total income. | | Rs. | a. p. | |
| Rs. a. p. | Rs. a. p. | | | | |
| 436 6 3 | 467 0 0 | | | | + 30 9 9 |

| PROFIT AND LOSS ACCOUNT OF THE SECOND YEAR. | | | Profit or loss. | | |
|---|---------------|--|-----------------|-------|----------|
| Total cost. | Total income. | | Rs. | a. p. | |
| Rs. a. p. | Rs. a. p. | | | | |
| 424 8 0 | 467 0 0 | | | | + 42 8 0 |

The profit increases successively as the manufacturer utilizes the appliances purchased for the first time in the following years.

Method of manufacturing "pakki chini" as practised in most of the refining centres.

To start work, the boiling pan which is permanently fixed on a mud furnace is thoroughly washed and cleaned. Fire is then applied underneath, and about 20 *gharás* of water (about four maunds in weight) poured into the pan. When the water begins to boil, about 14 maunds of *chínihá gur* is thrown into it and well

FIG. 29.



stirred with the *gurdam* (Figure No. 29), a T-shaped instrument, consisting of a piece of wood to which a long bamboo handle is fitted (Figure No. 29).

This process is technically called *karáh-ká-bojhná*.

When the *gur* has dissolved, *dudhání* or milk water, a mixture of milk and water, in proportion of one part of the former to 80 of the latter, is added to the boiling liquid gradually, to serve as a clarifying agent.

When the boiling has continued to a certain limit, 40 *gharás* or about eight maunds of water is added to the pan in order to dilute the liquid (*cháshni*). The heat in the furnace is now lowered and a moderate boiling kept on for two hours. During this interval the scum rises and accumulates on the surface of the boiling liquid, the process being known as "*kaugriáná*."

At this stage two *ghará*-fuls of plain water or "*rukhá*" is again poured into the pan to favour the separation of scum and its accumulation at the top. The

boiled liquid (*cháshni*) is removed with *sykás* (earthen vessels) (Figure No. 30) from the pan into the cloth strainer (*lothá*) kept on baskets of wickerwork (*kháñchá*) (Figure No. 31), through which the *cháshni* filters into earthen *nánds* (circular pots) below, the baskets being placed above the *nánds* over *sírhís* (bamboo framework similar to a ladder in shape) placed on the *nánds*, which are sunk into the ground. When the "*cháshni*" has all been strained in this manner the clear liquid (*shírá*) is removed from the *nánds*, six *gharás* being taken at a time, and transferred to the pan, which is thoroughly cleaned



FIG. 31.

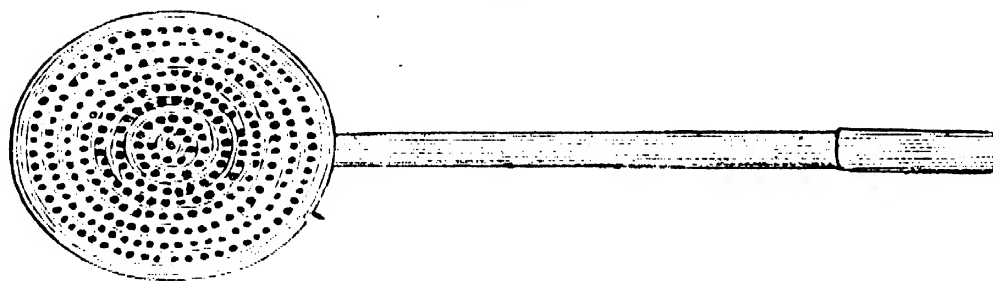


* The same as in the first year.

after each boiling by rubbing the inner surface with stones and by numerous washings. A strong fire is then applied underneath with a view to boiling the *shirā*. This process is known as *shirā-kā-bhujnā*. In the course of boiling a clarifying mixture is thrown into the liquid in small quantities, varying from four to six ounces, after every few minutes. This mixture is prepared by adding 1 lb of pounded castor seed to two gallons of water and allowing the mixture to stand for four days in order to let it ferment. If the mixture has not been sufficiently fermented, double the quantity of castor seed should be put into the water before the mixture can be fully active.

It is stated that the object of using this mixture is to prevent the crystals adhering to each other by means of the sticky uncrystallizable syrup; and that, except for the use of the mixture, the crystals would not separate from the molasses. The scum (*kaphaiyā*) rising to the surface is removed with a per-

FIG. 32.



forated iron shovel called "*paunā*" or "*jhadrā*" (Figure No. 32), and collected in one or more earthen pots known as

"*kaphaiyā-ki-mailāhi nānd*" sunk into the ground near the pan. The refuse (*patrā*)

FIG. 33.

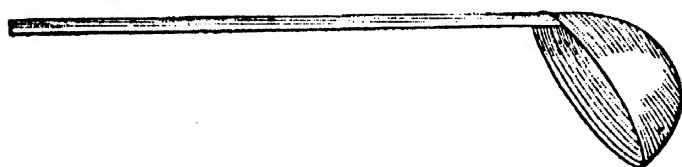


FIG. 34.



left in the several *lothās*, after the *shirā* has drained off, is removed with a *tāmā* (Figure No. 33) and tied up in one *lothā*, which is then placed on the *khām-hā* and is pressed with circular earthen weights (*bhirā*) (Figure No. 34).

The filtrate is restored to the pan to boil with a fresh instalment of *gur*. The refuse then left in the *lothā* is mixed with water and strained.

The liquid is known as *pasāwah*, and is usually given away as a treat to the menials of the factory, and the refuse left in the end is either thrown away as waste or mixed with dung to make fuel cakes (*kandā*). In Gorakhpur it is given to cattle.

The boiling is considered to be complete—

- (1) when the liquid is concentrated to about one-third of its original bulk;
- (2) when by holding a small quantity between the thumb and the first forefinger and removing one from the other an elastic thread appears between the two.

Another indication of the completion of boiling lies in the fact that big bubbles make their appearance on the surface and rush towards the centre of the pan, where they accumulate and disappear, and this phenomenon begins to recur with considerable rapidity.

The liquid is now transferred with a *támá* to an earthen pot "*khazána-kíná*" sunk into the ground close to the pan, and on the same level with it. *támá* (Figure No. 35) is an instrument consisting of a circular vessel made of iron, to which a wooden handle is firmly attached. As soon as this has been done a fresh instalment of *shirá* is introduced into the pan for boiling, and treated exactly in the manner just mentioned.



The liquid in the *khazána* is next removed with the *támá* to a set of three earthen pots, being poured successively from one into the other and stirred in each with the *támá* in order to cool it. Two *támás* are ordinarily used for stirring, one with each hand. Each of these three *nánds* is called *tagári* or *katni*, and they are so sunk in the mud structure close to the pan as to form a slope. From the third or the last *katni* the liquid is carried into another earthen pot known as *garh*, which is sunk lower down.

The *khazána* and the *garh* are usually larger in size than the pots known as *katni*, which are of equal dimensions.

From the third or the last *tagári* the liquid when cool is carried by means of a *parchá* and poured in fairly equal quantities into a series of earthen vessels (*nánds*) varying from four to six in number within a few yards of the pan.

This process is repeated after each instalment of *shirá* has been boiled and cooled down until the *nánds* (Figure No. 36) are filled up to the brim.

FIG. 36.



The *shirá* is allowed to stand in the *nánds* for a fortnight, during which period formation of crystals is completed and the contents of the *nánda* are then designated as *dána* or *mál*.

The *dána* is then scratched with the *belchá* (Figure No. 37), warm water being sprinkled with a view to separating the sugar crystals from the uncrystallizable syrup (*shirá*). The *mál* at this stage is transferred from the *nánds* by means of the *parchá* (Figure No. 38) to the oblong tank (*hauz*). At the bottom of the *hauz* bamboos are first placed lengthwise, and over them the same material is spread crosswise so as to form a sort of network, the structure being known as "*tattar*." The *tattar* is then covered over with mats (*gondri*) made of the aquatic grass *gond*. This arrangement is intended to serve as a filter.

FIG. 37.



FIG. 38. first placed lengthwise, and over them the same material is spread crosswise so as to form a sort of network, the structure being known as "*tattar*." The *tattar* is then covered over with mats (*gondri*) made of the aquatic grass *gond*. This arrangement is intended to serve as a filter.

The *haus* being filled with *māl*, the latter is left for three days to allow the *shīrā* to filter slowly through the mats and accumulate in a *nānd* sunk into the ground within a short distance of the *haus*. As the *nānd* becomes full, the *shīrā* is removed to a closed reservoir known as "*chahbachchā*." The mass within the

FIG. 39. *haus* is scratched after three days with "*gandāsās*" (Figure No. 39), so that the crystals may not stick together, and is levelled up with the hand. This process is technically called "*khatīānā*."



The operation which follows next has for its object the elimination of the colouring matter from the crystallized mass. The water weed commonly known as *sewār* is ordinarily used for this purpose. A layer of the weed one and a half inches thick is spread over the mass as soon as the operation known as "*khatīānā*" is completed. In the hot weather this layer is only about half as thick.

The weeds employed are of four different species :—

- | | | |
|----------------------|--|----------------------|
| (1) <i>Dubyakwā.</i> | | (3) <i>Duryahwā.</i> |
| (2) <i>Tisyahwā.</i> | | (4) <i>Patelā.</i> |

The layer of weeds spread on the surface of the *haus* is folded up after 24 hours and replaced by a fresh layer of the weed, which is again covered over with the old layer used before.

This operation is repeated daily for at least three days, until the mass within the tank in immediate contact with the weed has acquired a whitish colour to a depth of about an inch. This white layer is scraped off with the *soharnā* or *sutuhā* (Figure No. 40), and is collected within the tank in a corner. The mass underneath is now scratched with the *gandāsā*, and the white layer standing in the corner is evenly spread and covered over with weed (a fresh layer of *sewār*), over which the old layers of the weed are again spread as before.



This process is repeated once more after 24 hours. The top layer of the saccharine mass now assumes a white appearance. It is scraped off with the "*soharnā*" and removed to a *tāt* (*pātā*) spread on the floor to be exposed to the air. This product is known as *pachhni*, and is trodden under feet by two men till the crystals become perfectly white and the product is then called *chīni*. This process is known as *chīni kasnā*, and is intended to improve the colour of the crystals and prevent the formation of lumps. If the *pachhni* is not treated in this manner for a day or two, it ferments slightly and begins to give off an acid smell.

During hot days long exposure of the *pachhni* to the sun leads to a deterioration of the colour of the *chīni*. To produce the best quality of *chīni* the *pachhni* should at first be spread and trodden down in the shade for a short time, and then removed to the sunshine for treading. Successive layers of *pachhni* are scraped and treated in the manner described above until the *khātā* is emptied.

The *chîni* thus obtained is of the first quality and is known as *râs* or *phul*. The season for the manufacture of this kind of *chîni* ordinarily extends over six months, *viz.* December to May. It is passed through a common sieve to separate the fine crystals from the lumps (*turri*). The latter are either pounded or ground in a stone mill and mixed with the *râs* or kept apart and sold off separately at a lower price.

The uncrystallized syrup, *shîrâ*, which separates from the *mâl* is mixed with about one-twelfth of its weight of *gur* and boiled down.

The processes just described are repeated in the same order till *mâl* is produced, which is allowed to lie over in *nâsds* till October, when the *khandsâri* has sufficient leisure to deal with it. In October it is treated exactly in the same way as the *mâl* in the manufacture of *râs*, and an inferior class of *chîni*, called *domâ*, is thereby obtained.

The *shîrâ* which is obtained in the manufacture of the *domâ* after half the uncrystallizable syrup has drained off, is known as *topâri*. It is reboiled in November with the cleanings, scrapings, and other semi-refined products collected in the manufacture of the *râs* and the *domâ*, and treated in the same manner as before to get a still inferior form of *chîni* called *temâ*. The syrup produced in the last mentioned process is called *chotâ*, and is used in the manufacture of tobacco mixtures and as a drink by the lower classes of people.

Manufacture of "qand" and "misri" in Partâbgarh.

(a) "Qand."

Pakkî chîni, generally of the second class, is mixed with about one-third its weight of plain well water in an iron pan (*karâhi*)—Figure

FIG. 41.



surface of the boiling liquid with the *jharnâ* or *puniâ*—Figure No. 42 (a perforated

FIG. 42.

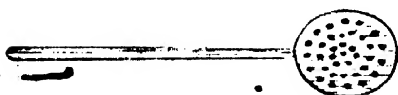


FIG. 43.



when the finger is raised about an inch above the thumb, the boiling is considered to be complete.

The partially cooled syrup is then transferred from the pan with the *dabbu* into conical earthen jars known as *kuzá* (Figures Nos. 44 to 46).

FIG. 44.

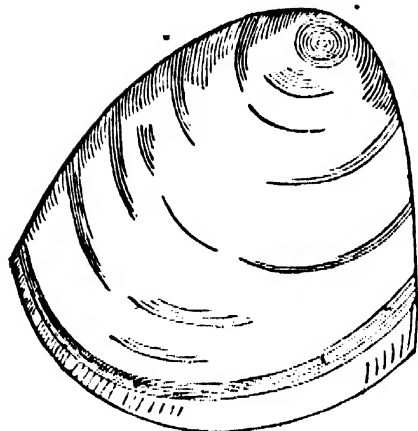


FIG. 45.

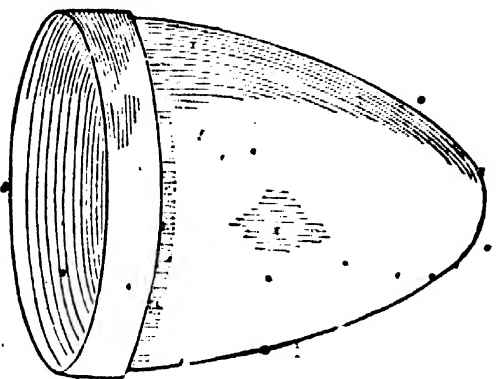
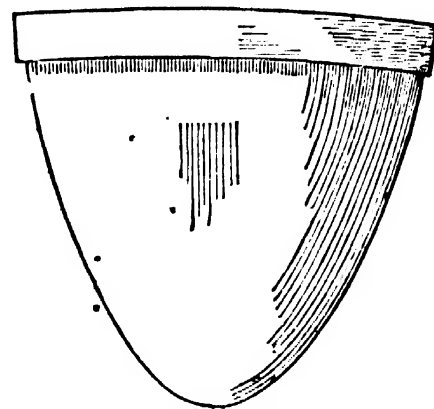


FIG. 46.



The *kuzá* is a hollow vessel, made of clay, circular at the top with a circumference of about two feet, tapering into a point downwards and having a small hole at the bottom, the vertical length of the jar being about $7\frac{1}{2}$ inches.

The hole in the jar is temporarily closed by sticking a small bit of paper over it outside with mucilage, and allowing it to get dry in the sun, several layers of paper being sometimes pasted one above the other in order to strengthen

FIG. 47.



the closure. The jar is now placed over an earthen pot (*metiá* or *maliá*)—Figure No. 47,—in order that it may maintain a vertical position, the inner surface of the jar being previously rubbed with a little *ghí* (clarified butter).

Before pouring the syrup (*cháshni*) into the jars a little dry *chíni* is thrown into the bottom in order to prevent the paper cover coming into immediate contact with the warm liquid and the closure giving way. While the *cháshni* in the jars is still warm, a pinch of clarified *chíni* (*burá* or *dubará* or *ghuti shakkar*) is sprinkled on the top of the liquid in each jar and stirred in with a piece of wood. This process is technically known as *jáwan dená* (adding “rennet”), and is said to help the crystallization materially. The *dubará* is prepared by boiling *pakki chíni* in water, and when sufficiently boiled, stirring the mass with wooden clubs till it is reduced to a white, fine powder.

The jars (*kuzá*) are again placed over an earthen pot and left for a day in the shade to allow crystallization. The layers of paper pasted over the aperture at the bottom of the jars are then removed, and the jars exposed to the sun for 24 hours. They are kept during the night in a sheltered place, the *shirá* trickling down all the time through the holes. A layer of *sewár* about an inch thick is spread over the surface of the mass in each *kuzá*, a piece of mud or stone about two seers in weight being placed above it. After 48 hours the layer of the weed is folded up and replaced by a fresh layer, over which the old one is unrolled and weights put on again.

FIG. 48.



After an interval of about 24 hours the white substance known as "*qand*" appearing on the surface of the mass in the "*kuzá*" is scraped off with a "*khurpi*" (Figure No. 48) and the surface of the mass is again treated with *sewár* in the manner just described. When the syrup has quite drained off, the mass is taken out of the *kuzá* and is known as "*qand*" (loaf sugar).

In an experiment made by us at Partábgarh six seers of *cháni* produced two seers nine chhatáks of *qand* and three seers six chhatáks of *shírá*.

The syrup obtained in the manufacture of *qand* is used in making sweetmeats.

(b) "*Misri*."

The *qand* thus manufactured is dissolved in about half its weight of water brought, as a rule, from a tank in village Katrá Abbanpur, within two miles of Partábgarh. It is called Ráni-ka-táláb, having been built by Ráni Suján Kuar of Partábgarh long before the annexation of Oudh. It comprises a total area of $32\frac{1}{2}$ acres, of which 18 acres are usually under water. It is asserted with an air of absolute certainty by the refiners that the highest possible degree of brilliancy and magnitude of sugar crystals cannot be attained unless the water from the tank is used for dissolving the *qand* to be refined, and a practical proof of the soundness of this belief was obtained in the past two years of famine, when the water in the tank dried up, and *misri* of the excellent quality for which Partábgarh is so famous could not then be turned out because well water had to be used instead.

The *qand* solution is then placed on a fire in the *karáhi* and allowed to boil, milk water (a mixture of one part milk with 30 parts of water) being poured in gradually to induce complete separation of impurities. These appear on the surface as scum, which is wholly removed with the *jhará* as in the case of *qand*. The transparent syrup is then removed from the fire, and passed through a cloth strainer into a separate vessel. The pan is then washed with "milk water" to dissolve the syrup sticking to its surface, and the solution added to the strained syrup. The latter is again restored to the pan, which is placed on a fire to boil again, till syrup of the required consistency is ready. This is determined by holding a small quantity of the syrup between the thumb and the finger, and rolling it into a pill. If the latter does not adhere to the fingers, the process of boiling is considered to be complete. The *cháshni* is then poured into shallow, brass moulds called *tháli* or *táthi* previously warmed before the fire and placed on a thick layer of warm wood ashes.

Immediately after this the mould is covered over with a basket or earthen *nánd* also warmed beforehand, which is again covered with woollen blankets in order to exclude the air as much as possible. The moulds are left in this condition for 18 to 24 hours, during which interval the crystallization is complete.

They are then taken out and a hole is made with a knife or rod in some corner of the crystallized mass in each mould. The moulds are then placed in a slanting position against the inner surface of a *karáhi*, within which a small wickerwork filter (usually a basket) is kept, in order to allow the uncrystallized syrup to slowly separate and trickle through the filter into the *karáhi*. This process occupies from eight to 12 hours. The dry sugar candy which is then removed from the moulds (*táthi*) is known as *misri*.

In an experiment carried out under our personal supervision at Partábgarh two seers nine chhatáks of *qand* gave two seers of *misri* and five chhatáks of *shirá*, the balance being loss.

Misri, when manufactured from *qand* as in *Partábgarh*, is the finest native refined sugar, having a most exquisite colour with a remarkable strength and brilliancy of crystals. It is not, however, the universal practice to use *qand* for its manufacture. Ordinarily it is prepared direct from *chíni* or beet sugar, the intermediate step of making *qand* being dispensed with. Under this process, when *misri* is manufactured from beet sugar, as is the common practice in *Cawnpore* and *Kálpí*, it is almost as good as that made from *qand*, though the lustre of the *Partábgarh* stuff is seldom attained; but when the material used is *chíni* instead of beet sugar, as is the custom in *Benares*, *Jaunpur*, and *Sultánpur*, the sugar candy produced is, as a rule, of inferior quality. The following is a brief description of the methods of making *misri* direct from *chíni* or beet sugar:—

There are two systems of manufacturing *misri* under this process, *viz.*, the *tháli* system and the *kuzá* system: each will be described separately.

I.—The “*tháli*” system.

Chíni is first dissolved in water, and the solution passed through a cloth

FIG. 49.



strainer. It is then boiled in an iron pan (Figure No. 49) over a furnace to a semi-liquid consistency, a mixture of milk and water being poured into it at intervals to clarify the sugar.

The scum removed with the *jharná* is collected in a separate vessel. When the *cháshni* (syrup) is ready, which is determined in the manner described under manufacture of *qand* at *Partábgarh*, the pan is lifted off the fire.

The syrup is then poured into shallow brass, tin, or stone vessels (*tháli*)

FIG. 50.



—Figure No. 50—previously placed on hot wood ashes. A little

ghí is also rubbed over the inner surface of the *tháli* before the *cháshni* is poured in, so that it may not stick to the moulds (*thális*). To exclude the passage of air the *thális* are wrapped

tightly in blankets and left for a day or two. During this

period the sugar crystallizes and the uncrystallized syrup settles down at the bottom. The *thális* are then unwrapped and holes made in some suitable corner of the crystallized mass.

They are then placed in a slanting position to allow the syrup to trickle down. When the syrup has been completely removed in this way, the crystallized mass is removed from the *tháli* and dried in the sun.

The syrup thus obtained is utilized in making *burá*, *gattá*, *batásá*, *jalebi*, *khájá*, or *gur*. The last named product is manufactured from syrup only in Benares, where it sells at seven seers a rupee.

The scum together with the washings of the pan is again boiled, clarified with milk, and converted into an inferior form of *burá*.

II.—The “*kuzá*” system.

In this system a mould known as *kuzá*—Figure No. 51 (a round vessel of varying dimensions made of clay, which holds from about three to six *chhatáks* of syrup)—is used instead of the *tháli*. The *cháshni* is boiled down to a less thick consistency, filled in the *kuzá*, and covered over with a blanket in the manner just described. Three to five thin sticks of bamboos tied together at one end, so as to form a conical shaped handle for lifting the lumps of sugar when ready, are placed in the moulds before the *cháshni* is poured in.



The moulds are kept wrapped up for about 24 hours. Their outer surface is then plastered over with mud, and they are kept for another 12 hours to favour the formation of crystals and accumulation of the syrup at the bottom. Holes are then made with a thin iron rod in each of the moulds, somewhere in the crystallized mass. The moulds are then placed upside down over some vessel to receive the syrup trickling down through the holes. When the syrup has been completely eliminated the moulds are broken, and their contents known as *kuzé-lj-misri* dried in the sun. The syrup obtained under this system is utilized in the same manner as that obtained under the *tháli* system.

Profits of the “misri” trade.—The profit and loss account for 1898 of a *halwái* who manufactures *misri* direct from *chíni* in Benares is given below:—

| EXPENDITURE. | | | | Price. | | |
|--|-----|-----|-----|--------|----|----|
| Name of article. | | | | Rs. | a. | p. |
| Thirteen maunds* of <i>chíni</i> at Rs. 9 per maund* | ... | ... | ... | 117 | 0 | 0 |
| Fuel ... | ... | ... | ... | 4 | 0 | 0 |
| Wages of boiler at three annas a maund | ... | ... | ... | 2 | 7 | 0 |
| 3,250 clay moulds (<i>kuzá</i>) | ... | ... | ... | 2 | 0 | 0 |
| Milk ... | ... | ... | ... | 0 | 13 | 0 |
| Cost of bamboo sticks | ... | ... | ... | 0 | 13 | 0 |
| Thread and paper | ... | ... | ... | 0 | 8 | 0 |
| Total expenditure | | | | 127 | 9 | 0 |

| INCOME. | | | | Price. | | |
|---|-----|-----|-----|--------|----|----|
| Name of article. | | | | Rs. | a. | p. |
| <i>Misri</i> , 6 maunds* 20 seers, at Rs. 14 per maund* | ... | ... | ... | 84 | 0 | 0 |
| <i>Burá</i> , 4 maunds* 35 seers, at Rs. 9 per maund* | ... | ... | ... | 43 | 14 | 0 |
| Total income | | | | 127 | 14 | 0 |

Total cost.
Rs. 127-9-0.

Total income.
Rs. 127-14-0.

Profit or loss.
+ Rs. 7-5-0.

* A local maund equals 42 standard seers.

The following is an account of profit and loss of the manufacture of *misri* direct from beet sugar :—

| EXPENDITURE. | | | | | Price. | | |
|---|-----|---------------|-----|-----------------|--------|----|----|
| Name of article. | | | | | Rs. | a. | p. |
| Beet sugar, 12 seers 6 chhatáks | ... | ... | ... | ... | 3 | 0 | 0 |
| Milk | ... | ... | ... | ... | 0 | 0 | 3 |
| Ghi | ... | ... | ... | ... | 0 | 0 | 3 |
| Wages of <i>halwái</i> | ... | ... | ... | ... | 0 | 0 | 9 |
| Fuel | ... | ... | ... | ... | 0 | 1 | 6 |
| Total cost | | | | | 3 | 2 | 9 |
| INCOME. | | | | | Price. | | |
| Name of article. | | | | | Rs. | a. | p. |
| 10 seers of <i>misri</i> , at 3 seers per rupee | ... | ... | ... | ... | 3 | 5 | 4 |
| 2 seers 4 chhatáks <i>burá</i> , at 5 seers per rupee | ... | ... | ... | ... | 0 | 7 | 2 |
| Total income | | | | | 3 | 12 | 6 |
| Total cost. | | Total income. | | Profit or loss. | | | |
| Rs. 3-2-9. | | Rs. 3-12-6. | | + Re. 0-9-9. | | | |

The figures of this account are based upon experiments carried out under our direct supervision at Cawnpore. These accounts do not include the hire of appliances used.

We give below the expenditure incurred in our experiments referred to under manufacture of *qand* and *misri* at *Partábgarh*, and the calculated profit in each :—

| EXPENDITURE. | | | | | Price. | | |
|---|-----|-------------|-----|-----------------|--------|----|----|
| Name of article. | | | | | Rs. | a. | p. |
| Six seers <i>chini</i> , at 4½ seers per rupee | ... | ... | ... | ... | 1 | 5 | 3 |
| Wages of <i>halwái</i> | ... | ... | ... | ... | 0 | 0 | 9 |
| Fuel | ... | ... | ... | ... | 0 | 0 | 6 |
| Cost of <i>sewár</i> | ... | ... | ... | ... | 0 | 0 | 6 |
| Milk | ... | ... | ... | ... | 0 | 0 | 3 |
| Total | | | | | 1 | 7 | 3 |
| INCOME. | | | | | Price. | | |
| Name of article. | | | | | Rs. | a. | p. |
| Price of 2 seers 9 chhatáks of <i>qand</i> , at 2 seers per rupee | ... | ... | ... | ... | 1 | 4 | 6 |
| " 3 seers 6 chhatáks of <i>shirá</i> , at 6 seers per rupee | ... | ... | ... | ... | 0 | 9 | 0 |
| Total | | | | | 1 | 13 | 6 |
| Total income. | | Total cost. | | Profit or loss. | | | |
| Re. 1-13-6. | | Re. 1-7-3. | | + Re. 0-6-3 | | | |

The following is the account of converting the above *qand* into *misri* :—

| EXPENDITURE. | | | | | Price. | | |
|---|-----|-------------|-----|-----------------|--------|----|----|
| Name of article. | | | | | Rs. | a. | p. |
| Cost of manufacture of <i>qand</i> as detailed above | ... | ... | ... | ... | 1 | 7 | 3 |
| Fuel | ... | ... | ... | ... | 0 | 0 | 6 |
| Ghi | ... | ... | ... | ... | 0 | 0 | 3 |
| Wages of <i>halwái</i> | ... | ... | ... | ... | 0 | 0 | 9 |
| Total cost | | | | | 1 | 8 | 9 |
| INCOME. | | | | | Price. | | |
| Name of article. | | | | | Rs. | a. | p. |
| Price of 2 seers of <i>misri</i> produced, at 1½ seers per rupee | ... | ... | ... | ... | 1 | 5 | 5 |
| " 3 seers 6 chhatáks of <i>shirá</i> obtained from <i>qand</i> , at 6 seers per rupee | ... | ... | ... | ... | 0 | 9 | 0 |
| Price of 5 chhatáks of <i>shirá</i> obtained from <i>misri</i> , at 6 seers per rupee | ... | ... | ... | ... | 0 | 0 | 10 |
| Total income | | | | | 1 | 15 | 3 |
| Total income. | | Total cost. | | Profit or loss. | | | |
| Re. 1-15-3. | | Re. 1-8-9. | | + Re. 0-6-6 | | | |

Burá.

Burá is a form of refined sugar very extensively used all over the country for consumption as an article of food and by the *halwáis* for the manufacture of sweetmeats.

The material employed for refining ranges from the most inferior forms of refined sugar such as *taraunchá* or “*domá*” to the best forms such as *phul* and *rás*.

Burá is also manufactured from beet sugar or from the latter mixed with country refined sugars.

The material to be refined is dissolved in water and the solution is strained. It is then boiled in an iron pan over a mud stove, milk and water being added to the liquid in order to clarify it. The scum is removed with the *jharuá* and kept separately. The boiling is continued till the required consistency

FIG. 52.



is attained. The pan is then removed from the fire and the contents kneaded violently with the wooden clubs (Figure No. 52) *doyá*, till the mass is cooled down. It is then reduced to a fine powder by rubbing it in the pan with an earthen vessel “*handiá*.” This powder is passed through a common sieve; the lumps, “*turri*,” are separated and reboiled with the next instalment of sugar or ground in a stone mill and mixed with the powder. The latter is known as *burá*, and sells in Cawnpore at Rs. 9 to Rs. 12 per local maund (46 seers) according to the quality.

A sugar maund (48.5 seers) of *chini* yields a *burá* maund (46 seers) of *burá* on the average.

Any syrup which is eliminated from the scum is boiled again and converted into *burá*.

Besni shakar.

When the material used for the manufacture of *burá* is *potti* instead of a refined sugar, the product is known as *besni shakar*, so called because of its resemblance in texture and colour to gram flour, “*besan*.”

Besni shakar used to be very largely manufactured and consumed in Oudh until a quarter of a century ago, when the number of *chini* factories was not so extensive as it is now. A hundred maunds of *potti* gives 77 maunds of *besni shakar*.

It is now a very common practice to mix beet sugar with inferior native refined sugars and to manufacture *burá* from this mixture.

Manufacture of “barsolá” and “gattá.”

Some inferior form of semi-refined sugar, such as *sewári shakar*, *taraunchá*, *darrá*, or *uthauwá* is first dissolved in water and then thoroughly boiled. When it acquires the required consistency, the boiled mass is removed from the fire and poured into an iron basin called “*toná*.” In this vessel it is partially cooled and becomes fairly solid. It is then taken out, rolled into a stick which is bent in the middle, and suspended at the centre on a wooden or iron peg driven into the wall.

The two ends of the stick are held by the *halwái*, who pulls them downwards. Being elastic, it yields to the manual force and expands like India rubber, but does not again contract. The prolonged portion is thrown back on the peg and pulled downwards again. This process is repeated for 25 to 35 minutes when the mass swells, becomes more or less spongy and brittle, and assumes a perfectly white colour. If necessary, some essence is added to it at this stage to flavour the sugar. The stick is then removed from the peg and placed on a wooden plank having a smooth surface and rolled with the hands. When it becomes fairly round, it is cut by means of a thread into small, round bits of a quarter of an inch or so in thickness. These bits as soon as they are cut are put into a warm earthen vessel filled with rice flour, and when thoroughly cooled they are taken out and are known by the name of "*barsolá*." The last process is necessary in order to prevent the bits from sticking to one another.

The manufacture of *barsolá* is confined mainly to the trans-Ghogra districts of Oudh.

Gattá is manufactured in the same way as *barsolá*, but the bits are never so thick, petals of rose and pieces of pistachio nut or cocoanut being sometimes stuck to their surface.

Kanauj is most famous for its *gattá* and Bahraich for *barsolá*.

Manufacture of "batásá."

Sugar is first dissolved in water in a pan and the solution is then thoroughly boiled over a mud oven heated by fire. When the liquid has acquired the proper consistency, it is taken out by instalments with the *dabuá*, an iron cup with an iron handle attached to it. The syrup in the *dabuá* is then sprinkled in drops over a cloth by means of a thin piece of wood. This cloth is spread over a mat or *tát* on the ground. The above process goes on till the whole syrup of the pan is exhausted. The "drops" lying on the cloth, when perfectly dry, are collected into a basket and are called "*batásá*."

CHAPTER X.

THE OUTTURN OF REFINED SUGARS, THE COST OF THEIR MANUFACTURE, AND THE PROFITS OF THE REFINING TRADE.

WE have devoted very considerable attention in the course of our enquiries to the determination of (a) the percentages of the outturn of the various products obtained from *gur* or *ráb* in the refining process, (b) the cost of refining, and (c) the refiner's profits. With a view to collecting accurate information with the most minute details on these heads, we have laboriously examined and tabulated the real accounts of a large number of refiners in various parts of the country for periods extending from two to seven years, and we are in possession of these accounts. We cannot, however, insert those lengthy statements except at the risk of imposing on the reader the laborious task of wading through a multitude of figures and drawing his own conclusions. We therefore confine ourselves to a few important remarks on each head.

I.—Manufacture of “*chîni*.”—(a) The various products obtained from “*gur*” —

(i) *Chîni*.—The total *chîni* obtained from a hundred maunds of *gur* has varied from 28·27 to 37·73. Of this the percentage of *râs* or first class *chîni* has ranged from 25·08 to 29·1 and of *domâ* or second class *chîni* has ranged from 3·19 to 8·63. The percentage of *temâ* or third class *chîni* is so insignificant that it may be neglected, in fact, in most of the refining centres *temâ* is never manufactured. The average outturn of *chîni*, taking into account all the statistics we have collected, comes to 33·22 per cent. of *gur*; and it may safely be assumed that practically three maunds of *gur* yield one maund of *chîni* on the average in this country.

(ii) *Chotâ* (molasses).—The percentage of *chotâ* in *gur* available for sale (part of the *chotâ* is, as a rule, consumed by labourers of the refinery as food) has varied from 29·9 to 51·94, and the average of all figures in our possession is 44·7 maunds. The average yield of *chotâ* may be put down at 45 per cent. of the *gur* refined.

(b) The cost of refining.—The cost of refining one maund of *gur* has been found to vary from Re. 0·6-3 to Re. 0·10-1, and the average cost for the whole province comes to Re. 0·8-9 per maund. It will be too tedious to comment on each and every item of the cost of refining, and an exhaustive discussion of details is therefore avoided. It is, however, interesting to note that one maund of fuel is generally believed to be sufficient to boil a maund of *gur* for refining. The cost of this quantity of firewood varies from two to three annas. Hence the cost of labour and miscellaneous expenses might on the average be reckoned as six annas per maund of *gur*.

(c) The refiner's profit.—With the data quoted above we now proceed to determine the profits of a refiner supposed to work his factory with his own capital, purchasing *gur* at Rs. 3 per maund—a price which will satisfy the cultivator in a majority of seasons—and selling his stock of *chîni* at Rs. 9 per maund, the average price which prevailed during the past few years, and the *chotâ* at Re. 1·8-3 per maund, the average of the prices of the past seven years. We shall base our calculation on 100 maunds of *gur*. His profit and loss account will then stand as follows :—

| RECEIPTS. | | | EXPENDITURE. | | |
|---|-----|-----------|--|-----|-----------|
| | | Rs. a. p. | | | Rs. a. p. |
| Price of 33 maunds of <i>chîni</i> at Rs. 9 | | | Price of 100 maunds of <i>gur</i> at Rs. 3 | | |
| per maund | ... | 297 0 0 | per maund | ... | 300 0 0 |
| Price of 45 maunds of <i>chotâ</i> at | | | Cost of refining | ... | 55 0 0 |
| Re. 1·8-3 per maund | ... | 77 5 6 | Profit | ... | 21 5 6 |
| Price of charcoal obtained from | | | | | |
| the firewood burnt | ... | 2 0 0 | | | |
| Total | ... | 376 5 6 | Total | ... | 376 5 6 |

It will be seen that for every Rs. 355 laid out, the refiner makes a profit of Rs. 21-5-6, i.e., 6 per cent. of the outlay. This small gain is just sufficient to cover the interest on capital at 12 per cent. per annum for six months, the

period during which his money remains sunk in the business. It is obvious that a further margin of profit will only accrue if the *gur* can be had at a lower, or *chîni* and *chotâ* sold at a higher, price. These facts go to prove that so long as *chîni* sells at the low price of Rs. 9 per maund, the refiner's business cannot be a profitable one; unless *gur* sells cheaper than Rs. 3 per maund, which, on the other hand, cannot take place except at the expense of the cultivator's profits.

II. — (a) Manufacture of "*khând*" —

(i) *Bel-râb*.—One hundred maunds of *bel-râb* has been found to produce 26·1 to 35 maunds of *khând*. With reference to figures, compiled from five years' accounts of several refiners, the average outturn of *khând* per hundred maunds of *bel-râb* comes to 31. Half of this may be counted as *râs* or *phul* (first class *khând*), one-fourth as *adhautâ* (second class), and the rest as *taramuchâ* (third class).

(ii) *Sâir-râb*.—*Râb* manufactured under the *sâir* system has been found to produce 28 per cent. of *khând*.

The percentage of *shîrâ* in *râb* in general has varied from 50·3 to 60·9 according to the quality of the *râb*. The average percentage of *shîrâ* in *bel-râb* has been found to be 52·5 and in *sâir-râb* 55.

(b) The cost of refining the *sâir* and the *bel-râb* is uniform. It varies from Re. 0-2-3 to Re. 0-6-9 per maund. Taking all the accounts into consideration the average cost may be put down at Re. 0-4-0 per maund of *râb*.

(c) *The refiner's profit*.—With these data in our hands we may now calculate the profits of a refiner supposed to work his factory with his own capital, purchasing *bel-râb* at Rs. 3 and *sâir-râb* at Rs. 2-14-0 a maund (the average rates prevalent during the past few years) and selling the *khând* manufactured from them at Rs. 8-12-0 and Rs. 8-8-0 a maund, respectively, and the *shîrâ* at Re. 1-8-0 per maund. His accounts will then stand as follows:—

| RECEIPTS. | | | <i>Bel-râb.</i> | | | EXPENDITURE. | | |
|--|-----|-----------|-----------------|--|-----|--------------|-----------|--|
| | | Rs. a. p. | | | | | Rs. a. p. | |
| Price of 31 maunds of <i>khând</i> at Rs. 8-12-0 a maund | ... | 271 0 0 | } | Price of 100 maunds of <i>râb</i> at Rs. 3 | ... | 300 0 0 | | |
| Price of 52 maunds of <i>shîrâ</i> at Re. 1-8-0 a maund | ... | 78 12 0 | | per maund | ... | 25 0 0 | | |
| | | | | Cost of refining | ... | 24 12 0 | | |
| | | | | Profit | ... | | | |
| Total | ... | 349 12 0 | | Total | ... | 349 12 0 | | |

| RECEIPTS. | | | <i>Sâir-râb.</i> | | | EXPENDITURE. | | |
|---|-----|-----------|------------------|---|-----|--------------|-----------|--|
| | | Rs. a. p. | | | | | Rs. a. p. | |
| Price of 28 maunds of <i>khând</i> at Rs. 8-8-0 a maund | ... | 238 0 0 | } | Price of 100 maunds of <i>râb</i> at Rs. 2-14-0 | ... | 287 8 0 | | |
| Price of 55 maunds of <i>shîrâ</i> at Re. 1-8-0 a maund | ... | 82 8 0 | | a maund | ... | 25 0 0 | | |
| | | | | Cost of refining | ... | 8 0 0 | | |
| | | | | Profit | ... | | | |
| Total | ... | 320 8 0 | | Total | ... | 320 8 0 | | |

It appears from the first account that the refiner gains Rs. 24-12-0 on his investment of Rs. 325 and from that of the second Rs. 8 on an investment of Rs. 312-8-0, i.e., 7½ per cent. in the former case and 2½ per cent. in the latter.

In order to enable the reader to form a clearer notion of the details of the refining business, we subjoin two statements (A and B), which have been prepared

with great care from the real accounts for a number of years of selected manufacturers of *chîni* and *khând* in different districts whose books appeared to be most reliable. These statements show the variations in the quantity of different products and the amount of profit and loss according to different qualities of the refining materials used, their rate per maund, and the cost of manufacture in each year:—

A.—Statement showing certain particulars of the “*chîni*” maker’s business.

| Year. | District. | Name of refiner. | Average price per maund. | | | Cost of refining per maund. | Profit on every Rs. 100 of refiner’s outlay. | Loss on every Rs. 100 of refiner’s outlay. |
|-------|--------------|------------------|--------------------------|-----------|-----------|-----------------------------|--|--|
| | | | Gur. | Chîni. | Chotâ. | | | |
| | | | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. |
| 1892 | Jaunpur ... | B. L. ... | 2 15 0 | 8 9 11 | 1 13 4 | 0 10 0 | ... | 5 1 2 |
| 1893 | | | 2 12 1 | 9 6 7 | 1 7 0 | 0 10 1 | 13 0 5 | ... |
| 1894 | | | 3 1 6 | 9 3 0 | 1 8 9 | 0 8 3 | 11 6 10 | ... |
| 1895 | | | 3 0 5 | 9 8 0 | 1 12 0 | 0 9 5 | 11 9 0 | ... |
| 1896 | | | 3 1 0 | 8 13 0 | 1 12 7 | 0 8 1 | 1 1 10 | ... |
| 1897 | Azamgarh ... | S. R. A.... | 4 1 6 | 9 3 4 | 2 15 4 | 0 7 3 | ... | 0 15 7 |
| 1897 | Jaunpur ... | B. L. ... | 3 10 10 | 9 3 9 | 2 12 0 | 0 9 11 | 9 5 9 | ... |
| 1897 | Azamgarh ... | S. R. A.... | 3 5 1 | 9 2 6 | 1 14 5 | 0 8 5 | ... | 2 13 7 |
| 1898 | Sultânpur... | R. P. ... | 3 4 9 | 8 12 11 | 1 12 0 | 0 7 6 | 4 11 7 | ... |
| | | G. H. ... | 3 2 4 | 8 9 0 | 1 15 4 | 0 6 3 | ... | 8 1 7 |
| | | L. H. ... | 3 4 2 | 8 3 8 | 1 10 4 | 0 6 9 | ... | 11 3 0 |
| | | T. H. ... | 3 1 3 | 7 13 9 | 1 9 10 | 0 9 9 | ... | 12 8 4 |
| | | | 3 0 0 | 7 7 2 | 1 9 7 | 0 6 6 | ... | 8 12 2 |

B.—Statement showing certain particulars of the “*khând*” maker’s business.

| Year. | District. | Name of refiner. | Average price per maund. | | | Cost of refining per maund. | Profit on every Rs. 100 of refiner’s outlay. | Loss on every Rs. 100 of refiner’s outlay. | Remarks. |
|-------|---------------|------------------|--------------------------|-----------|-----------|-----------------------------|--|--|--|
| | | | Râb. | Khând. | Shîrâ. | | | | |
| | | | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. | Rs. a. p. | |
| 1895 | Shâhjahânpur. | B. P. ... | 2 12 1 | 8 4 0 | 2 6 3 | 0 2 11 | 13 15 6 | ... | Gain due chiefly to low price of <i>râb</i> and high price of <i>khând</i> . |
| 1895 | | | 3 0 11 | 10 14 11 | 1 6 8 | 0 5 7 | 17 8 10 | ... | |
| 1896 | | | 2 15 9 | 8 1 9 | 1 0 2 | 0 3 2 | ... | 2 12 5 | |
| 1897 | | | 2 10 3 | 9 2 5 | 1 13 0 | 0 6 8 | 29 14 6 | ... | |
| 1898 | | K. L.... | 3 11 6 | 8 12 1 | 1 13 0 | 0 4 10 | ... | 9 5 3 | |
| 1898 | | | 3 1 1 | 8 12 1 | 1 1 0 | 0 2 7 | ... | 3 5 11 | |

It will appear from these statements that there has been a loss in the refining business continually since 1896. The only exception is the case of S. R. A. of Azamgarh, who, however, worked his factory with his own capital, and had to pay no interest in 1897. In 1898 part of his capital was borrowed, and in that year the profits declined proportionately. In the case of all other

refiners the business was carried on with capital borrowed at different rates of interest. The loss during the past few years may be traced to two causes—the low price of the finished product and the high cost of the raw material. The former is due to the competition of foreign imported sugars, sold at a low price and very attractive in appearance. As the result of these losses the prices offered for *gur* and *rāb* during the season of 1899 were distinctly below those of the preceding year, thus transferring to the cultivator part of the manufacturer's loss. At the present time the condition of the industry is unsettled; things cannot continue permanently on the present footing, and if the price of the refined product cannot be raised, the price of *gur* and *rāb* must fall, thus diminishing the cultivator's profits and tending to reduce the area under the crop.

CHAPTER XI.

THE QUANTITY OF SUGAR PRODUCED AND CONSUMED IN THE UNITED PROVINCES.

REFERENCE has already been made in the chapter on races of sugar-cane (*vide* page 28) to the crop-cutting experiments which we carried out with a view to determining the outturn of raw sugar in each district. By far the largest number of these experiments were in making *gur*, a few of them were made in the preparation of *rāb*, and fewer still in the manufacture of *shakkar*. The results of the experiments are embodied in a number of statements which we subjoin.

STATEMENT A.—Showing the average outturn of “gur” per acre in each district.

| Name of district. | Number of experiments carried out. | Total area experimented on (in square yards). | Average yield per acre in maunds. | | | Percentage of— | | |
|-------------------|------------------------------------|---|-----------------------------------|------------------|----------------|----------------|---------------|------------------|
| | | | Weight of cane. | Weight of juice. | Weight of gur. | Juice in cane. | Gur in juice. | Gur in cane. |
| Dehra Dūn ... | 2 | 605 | 275.00 | 200.84 | 33.71 | 73.03 | 16.78 | 12.20 |
| Sahāranpur ... | 12 | 5,808 | 304.67 | 187.23 | 29.93 | 61.45 | 15.99 | 9.82 |
| Muzaffarnagar ... | 9 | 3,872 | 416.69 | 222.18 | 39.42 | 53.32 | 17.75 | 9.46 |
| Meerut ... | 7 | 3,146 | 390.87 | 230.06 | 39.13 | 61.16 | 16.37 | 16.01 |
| Bulandshahr... | 2 | 968 | 295.25 | 161.87 | 31.41 | 54.83 | 19.40 | 10.64 |
| Aligarh ... | 3 | 1,452 | 255.83 | 131.18 | 26.17 | 51.27 | 19.44 | 10.22 |
| Muttra ... | 2 | 968 | 332.10 | 152.16 | 27.74 | 45.81 | 18.54 | 8.68 |
| Agra ... | 9 | 4,356 | 378.90 | 201.72 | 32.44 | 53.23 | 16.07 | 8.56 |
| Farrukhabad... | 27 | 12,718 | 251.66 | 128.27 | 25.13 | 50.96 | 19.59 | 9.98 |
| Mainpuri ... | 4 | 1,452 | 218.06 | 115.64 | 19.48 | 54.27 | 11.84 | 9.14 |
| Etāwah ... | 3 | 1,352 | 207.00 | 101.43 | 17.02 | 49.00 | 16.17 | 8.22 |
| Etah ... | 2 | 968 | 236.05 | 129.63 | 20.26 | 54.41 | 15.62 | 8.58 |
| Barcilly ... | 5 | 2,420 | 326.62 | 178.15 | 27.99 | 54.54 | 15.71 | 8.57 |
| Bijnor ... | 5 | 2,420 | 315.72 | 182.59 | 30.77 | 58.15 | 16.76 | 9.74 |
| Budaun ... | 5 | 2,420 | 273.35 | 130.51 | 25.57 | 47.74 | 19.59 | 9.36 |
| Moradabad ... | 5 | 2,420 | 279.76 | 167.52 | 30.29 | 59.88 | 18.08 | 10.83 |
| Shāhjahānpur ... | 2 | 968 | 350.59 | 187.98 | 33.77 | 53.61 | 17.96 | 9.63 |
| Pilibhīt ... | 1 | 242 | 385.00 | 210.00 | 31.81 | 54.54 | 15.15 | 8.26 |
| Cawnpore ... | 6 | 2,904 | 268.75 | 150.28 | 23.07 | 55.95 | 15.35 | 8.58 |

STATEMENT A.—Showing the average outturn of “gur” per acre in each district—(concluded).

| Name of district. | Number of experiments carried out. | Total area experimented on (in square yards). | Average yield per acre in maunds. | | | Percentage of— | | |
|-------------------|------------------------------------|---|-----------------------------------|------------------|----------------|----------------|---------------|--------------|
| | | | Weight of cane. | Weight of juice. | Weight of gur. | Juice in cane. | Gur in juice. | Gur in cane. |
| Fatehpur ... | 11 | 5,324 | 318.81 | 151.94 | 26.16 | 47.66 | 17.22 | 8.21 |
| Hamirpur ... | 9 | 4,356 | 274.48 | 135.82 | 23.76 | 51.89 | 17.49 | 9.12 |
| Allahabad ... | 11 | 4,840 | 324.08 | 179.67 | 33.63 | 55.44 | 18.71 | 10.36 |
| Jhānsi ... | 4 | 1,210 | 294.35 | 140.43 | 25.72 | 47.71 | 18.32 | 8.74 |
| Jalaun ... | 1 | 121 | 280.00 | 132.00 | 28.00 | 47.64 | 21.21 | 10.00 |
| Benāres ... | 4 | 1,936 | 349.67 | 187.73 | 35.46 | 52.49 | 18.89 | 10.14 |
| Mirzapur ... | 6 | 2,662 | 294.36 | 180.86 | 26.85 | 61.44 | 14.84 | 9.12 |
| Jaunpur ... | 3 | 968 | 299.25 | 129.75 | 28.10 | 43.36 | 21.65 | 9.39 |
| Ghāzipur ... | 14 | 5,324 | 384.90 | 211.79 | 38.75 | 55.02 | 18.29 | 10.77 |
| Ballia ... | 8 | 3,630 | 512.07 | 264.48 | 48.14 | 51.65 | 18.20 | 9.90 |
| Gorakhpur ... | 8 | 2,662 | 430.18 | 189.69 | 37.29 | 44.09 | 19.65 | 8.66 |
| Basti ... | 14 | 6,776 | 311.35 | 161.77 | 30.10 | 51.96 | 18.62 | 9.67 |
| Azamgarh ... | 1 | 242 | 575.00 | 335.41 | 45.97 | 58.33 | 13.75 | 7.99 |
| Naini Tal ... | 2 | 606 | 212.00 | 126.00 | 20.50 | 59.43 | 16.26 | 10.14 |
| Lucknow ... | 2 | 1,060 | 323.05 | 163.40 | 33.88 | 50.27 | 20.86 | 10.49 |
| Unao ... | 1 | 484 | 290.60 | 148.04 | 29.00 | 50.96 | 19.59 | 9.98 |
| Rae Bareilly ... | 1 | 484 | 370.00 | 185.50 | 28.75 | 50.13 | 15.50 | 7.77 |
| Sitapur ... | 7 | 2,904 | 341.17 | 189.38 | 32.88 | 55.51 | 17.36 | 9.64 |
| Hardoi ... | 4 | 1,452 | 354.23 | 194.83 | 31.63 | 55.00 | 16.23 | 8.93 |
| Kheri ... | 22 | 9,314 | 349.26 | 185.72 | 27.69 | 53.18 | 14.91 | 7.93 |
| Kyazabad ... | 15 | 7,260 | 481.45 | 199.82 | 33.41 | 41.33 | 16.72 | 6.98 |
| Gondā ... | 5 | 2,420 | 267.70 | 117.90 | 21.77 | 44.03 | 18.47 | 8.13 |
| Bahraich ... | 2 | 968 | 322.50 | 170.75 | 27.56 | 52.95 | 16.14 | 8.55 |
| Sultānpur ... | 2 | 1,360 | 347.91 | 147.28 | 30.15 | 42.33 | 20.47 | 8.66 |
| Partabgarh ... | 2 | 968 | 484.50 | 242.50 | 40.75 | 50.05 | 16.80 | 8.41 |
| Bara Bank ... | 1 | 484 | 316.25 | 188.75 | 30.00 | 59.68 | 15.79 | 9.49 |

STATEMENT B.—Showing the highest outturn of “gur” in certain districts.

| Name of district. | Kind of cane experimented with. | Number of experiments carried out. | Total area experimented on (in square yards). | Highest yield per acre in maunds. | | | Percentage of— | | |
|-------------------|---------------------------------|------------------------------------|---|-----------------------------------|------------------|----------------|----------------|---------------|--------------|
| | | | | Weight of cane. | Weight of juice. | Weight of gur. | Juice in cane. | Gur in juice. | Gur in cane. |
| Dehra Dūn ... | Pansāhi | 1 | 484 | 470.00 | 352.50 | 56.00 | 75.00 | 15.82 | 11.87 |
| Sahāranpur ... | Do. | 2 | 968 | 540.62 | 316.49 | 54.06 | 58.14 | 17.08 | 10.00 |
| Meerut ... | Dhaul | 1 | 242 | 462.50 | 278.06 | 51.41 | 60.12 | 18.48 | 9.14 |
| Muttra ... | Lalri | 1 | 484 | 457.50 | 267.30 | 53.75 | 56.25 | 20.88 | 11.74 |
| Allahabad ... | Tankā | 2 | 968 | 552.81 | 317.85 | 61.45 | 57.50 | 19.33 | 11.12 |
| Mirzapur ... | Reorā | 2 | 484 | 465.80 | 250.00 | 52.37 | 53.67 | 20.95 | 11.24 |
| Ghāzipur ... | Pansāri | 7 | 2,904 | 569.74 | 337.31 | 71.41 | 59.20 | 21.17 | 12.53 |
| Ballia ... | Do. | 4 | 1,936 | 591.87 | 293.42 | 68.12 | 49.33 | 23.32 | 11.50 |
| Gorakhpur ... | Reorā and Pansāhi. | 2 | 726 | 541.33 | 313.42 | 67.55 | 57.90 | 21.55 | 12.48 |
| Azamgarh ... | Reorā | 1 | 242 | 466.10 | 332.01 | 52.03 | 71.25 | 15.67 | 11.17 |
| Kheri ... | Dhaur | 1 | 242 | 432.00 | 270.00 | 55.00 | 62.50 | 20.37 | 12.73 |

STATEMENT C.—Showing the average outturn of “*râb*” in the chief “*râb*” producing districts.

| Name of district. | Number of experiments carried out. | Total area experimented on (in square yards). | Average yield per acre in maunds. | | | Percentage of— | | |
|-------------------|------------------------------------|---|-----------------------------------|------------------|------------------------|----------------|----------------------|---------------------|
| | | | Weight of cane. | Weight of juice. | Weight of <i>râb</i> . | Juice in cane. | <i>Râb</i> in juice. | <i>Râb</i> in cane. |
| Sahâranpur ... | 3 | 1,452 | 356.90 | 220.09 | 40.65 | 61.67 | 18.47 | 11.39 |
| Aligarh ... | 3 | 1,452 | 372.23 | 165.37 | 33.57 | 44.42 | 20.30 | 9.02 |
| Bareilly ... | 3 | 1,452 | 279.00 | 135.06 | 23.77 | 48.41 | 17.59 | 8.52 |
| Bijnor ... | 3 | 1,452 | 261.25 | 146.28 | 24.75 | 55.35 | 16.91 | 9.37 |
| Budaun ... | 3 | 968 | 319.12 | 175.62 | 33.62 | 55.03 | 19.15 | 10.54 |
| Moradabad ... | 3 | 666 | 368.97 | 206.47 | 46.58 | 55.96 | 22.56 | 12.62 |
| Shâhjahanpur ... | 2 | 968 | 350.39 | 187.98 | 37.15 | 53.61 | 19.88 | 10.59 |
| Pilibhit ... | 4 | 1,694 | 390.64 | 171.21 | 33.43 | 43.16 | 19.58 | 8.56 |
| Jaunpur ... | 1 | 242 | 387.40 | 189.20 | 27.40 | 48.83 | 14.48 | 7.07 |
| Azamgarh ... | 1 | 242 | 515.00 | 289.00 | 36.40 | 56.12 | 16.05 | 9.01 |

STATEMENT D.—Showing the highest outturn of “*râb*” in certain districts.

| Name of district. | Kind of cane. | Number of experiments carried out. | Total area experimented on (in square yards). | Highest yield per acre in maunds. | | | Percentage of— | | |
|-------------------|---------------|------------------------------------|---|-----------------------------------|------------------|------------------------|----------------|----------------------|---------------------|
| | | | | Weight of cane. | Weight of juice. | Weight of <i>râb</i> . | Juice in cane. | <i>Râb</i> in juice. | <i>Râb</i> in cane. |
| Sahâranpur ... | Paundâ | 1 | 121 | 760.00 | 534.80 | 84.80 | 70.37 | 15.74 | 11.16 |
| Bijnor ... | Dhaul | 1 | 484 | 420.50 | 249.49 | 52.91 | 59.33 | 21.21 | 12.58 |
| Gorakhpur ... | Pansâhi | 1 | 242 | 480.00 | 328.80 | 70.00 | 68.50 | 21.29 | 14.58 |

STATEMENT E.—Showing the outturn of “*shakkar*” in certain districts.

| Name of district. | Number of experiments carried out. | Total area experimented on (in square yards). | Average yield per acre in maunds. | | | Percentage of— | | |
|-------------------|------------------------------------|---|-----------------------------------|------------------|----------------------------|----------------|--------------------------|-------------------------|
| | | | Weight of cane. | Weight of juice. | Weight of <i>shakkar</i> . | Juice in cane. | <i>Shakkar</i> in juice. | <i>Shakkar</i> in cane. |
| Sahâranpur ... | 4 | 1,936 | 356.78 | 191.02 | 27.87 | 53.51 | 14.59 | 8.40 |
| Muzaffarnagar ... | 1 | 484 | 306.25 | 166.00 | 27.25 | 54.21 | 16.42 | 8.90 |
| Bijnor ... | 3 | 1,452 | 267.63 | 147.50 | 29.09 | 55.11 | 19.72 | 10.87 |

Statement A gives the average outturn of *gur* per acre in each district. In determining these averages we have not included the figures of the experiments in which the outturn of *gur* exceeded 50 maunds per acre. We believe that outturns beyond this limit are obtained only in very exceptional cases under particularly high cultivation and specially favourable conditions. The inclusion of these extraordinarily high figures would have in many cases vitiated our averages and given the reader a quite misleading notion of the sugar-producing capacity of several districts. The figures, though not therefore included in the averages, have been shown separately in Statement B, in order to enable the reader to form an idea of the highest outturns we have obtained in certain districts in special cases.

In Statement C we have shown similarly the average outturn per acre of *râb* in the *râb*-producing districts. The averages are based upon outturns not exceeding 50 maunds per acre. The results of experiments in which higher outturns were obtained have for reasons quoted above been noted in Statement D.

Statement E gives the outturns of *shakkar* per acre in the districts where experiments in the manufacture of that product could be carried out.

With reference to Statement A, it should be observed that in districts where the number of experiments in the manufacture of *gur* was insufficient to justify a proper estimation of the average outturn of the district and the juice had in most cases to be necessarily boiled into *râb* on account of objection on the part of cultivators to whom the crops under experiment belonged to having the juice made into *gur*, the produce of *râb* was calculated in terms of *gur* and the yield of *gur* thus arrived at included in the average of the district. Samples of *râb* differ somewhat in consistency, and so do the various forms of *gur*. The *bel-râb* is generally thicker than the *sâir-râb*, and in case of the latter *dharkauân* is never so thick as *bandhauân*.

Among the various forms of *gur*, *pâri* is always softer than the *bheli*, and contains more moisture. *Muthiâ* is generally harder than the common *bheli* and contains less moisture.

Thus it is somewhat difficult to establish a definite mathematical ratio between the produce of *râb* and *gur*; but it may safely be reckoned that the quantity of juice sufficient to yield 10 of *râb* will produce about 9 of *gur* or 8 of *shakkar*. Our calculations for Statement A are based on these figures.

Having ascertained by crop-cutting experiments the average outturn of *gur* in each district as shown above in Statement A, we may now proceed to determine the total amount of *gur* that these Provinces may be expected to produce in a fairly good agricultural year and the average outturn per acre for each division; the outturn during the year for each district being obtained by multiplying the average for the past 12 years 1886-87 to 1897-98 of the area under cane cultivation in the district by the average outturn per acre in the district as

ascertained by our crop-cutting experiments. The calculations are shown in the following table (Statement F) :—

STATEMENT F.

| District. | | | Average area under sugarcane cultivation for 12 years.* | Average yield of <i>gur</i> per acre. | Average total annual outturn of <i>gur</i> . | Average yield of <i>gur</i> for each division. |
|----------------------------|-----|-----|--|---|--|---|
| | | | Acres. | Mds. | Mds. | Mds. |
| Dehra Dûn | ... | ... | 1,429 | 34 | 48,586 | |
| Sahāranpur | ... | ... | 41,523 | 30 | 12,45,690 | |
| Muzaffarnagar | ... | ... | 67,117 | 39 | 26,17,563 | |
| Meerut | ... | ... | 1,06,554 | 39 | 41,55,606 | |
| Bulandshahr | ... | ... | 23,175 | 31 | 7,18,425 | |
| Aligarh | ... | ... | 3,882 | 26 | 1,00,932 | |
| Total, Meerut Division | | | 2,43,680 | ... | 88,86,802 | 36 |
| Muttra | ... | ... | 1,320 | 28 | 36,960 | |
| Agra | ... | ... | 3,360 | 32 | 1,07,520 | |
| Farrukhabad | ... | ... | 17,609 | 25 | 4,40,225 | |
| Mainpuri | ... | ... | 9,696 | 19 | 1,84,224 | |
| Etāwah | ... | ... | 9,732 | 17 | 1,65,444 | |
| Etah | ... | ... | 14,525 | 20 | 2,90,500 | |
| Total, Agra Division | | | 56,242 | ... | 12,24,873 | 22 |
| Bareilly | ... | ... | 54,690 | 28 | 15,30,320 | |
| Bijnor | ... | ... | 68,288 | 31 | 21,16,928 | |
| Budaun | ... | ... | 23,560 | 26 | 6,12,560 | |
| Moradabad | ... | ... | 56,583 | 30 | 16,97,490 | |
| Shāhjhānpur | ... | ... | 52,270 | 34 | 17,77,180 | |
| Pilibhit | ... | ... | 36,309 | 32 | 11,61,888 | |
| Total, Rohilkhand Division | | | 2,91,700 | ... | 88,96,366 | 34 |
| Cawnpore | ... | ... | 9,940 | 23 | 2,28,620 | |
| Fatehpur | ... | ... | 4,876 | 26 | 1,26,776 | |
| Bānda | ... | ... | 30 | ... | ... | |
| Hamirpur | ... | ... | 2,975 | 24 | 71,400 | |
| Allahabad | ... | ... | 12,663 | 34 | 4,30,542 | |
| Jhānsi | ... | ... | 1,246 | 26 | 32,296 | |
| Balaun | ... | ... | 1,088 | 28 | 30,464 | |
| Total, Allahabad Division | | | 32,818 | ... | 9,20,098 | 28 |
| Begares | ... | ... | 20,231 | 35 | 7,08,085 | |
| Mirzapur | ... | ... | 10,846 | 27 | 2,92,842 | |
| Jaunpur | ... | ... | 52,425 | 28 | 14,67,900 | |
| Ghāzipur | ... | ... | 31,979 | 39 | 12,47,181 | |
| Ballia | ... | ... | 36,605 | 48 | 17,57,040 | |
| Total, Benares Division | | | 1,52,086 | ... | 54,73,048 | 35 |

STATEMENT F—(concluded).

| District. | Average area under sugarcane cultivation for 12 years.* | Average yield of <i>gur</i> per acre. | Average total annual outturn of <i>gur</i> . | Average yield of <i>gur</i> for each division. |
|-----------------------------------|--|---|--|---|
| | Acres. | Mds. | Mds. | Mds. |
| Gorakhpur ... | 71,861 | 37 | 26,58,857 | |
| Basti ... | 42,161 | 30 | 12,64,830 | |
| Azamgarh ... | 74,719 | 45 | 33,62,355 | |
| Total, Gorakhpur Division ... | 1,88,741 | ... | 72,86,042 | 38 |
| Almora ... | ... | ... | ... | |
| Garhwál ... | ... | ... | ... | |
| Naiñi Tal ... | 4,876 | 21 | 1,02,396 | |
| Total, Kumaun Division ... | 4,876 | ... | 1,02,396 | 21 |
| Lucknow ... | 4,251 | 34 | 1,44,534 | |
| Unao ... | 15,191 | 29 | 4,40,539 | |
| Rae Bareilly ... | 4,804 | 29 | 1,39,316 | |
| Sitapur ... | 30,124 | 33 | 9,94,092 | |
| Hardoi ... | 26,766 | 32 | 8,56,512 | |
| Kheri ... | 36,163 | 28 | 10,12,564 | |
| Total, Lucknow Division ... | 1,17,299 | ... | 35,87,557 | 30 |
| Fyzabad ... | 41,009 | 33 | 13,53,297 | |
| Gonda ... | 21,137 | 22 | 4,65,014 | |
| Bahraich ... | 3,485 | 28 | 97,580 | |
| Sultánpur ... | 20,311 | 30 | 6,09,330 | |
| Partábgarh ... | 12,576 | 41 | 5,15,616 | |
| Bara Banki ... | 26,354 | 30 | 7,90,620 | |
| Total, Fyzabad Division ... | 1,24,872 | ... | 38,31,457 | 30 |
| Total, U. P. of Agra and Oudh ... | 12,12,314 | 33† | 4,02,08,639 | ... |

* 1886-87 to 1897-98.

† Average for the whole Province obtained by dividing the total outturn by the total area.

It will appear from the above statement that the highest average outturn of *gur*, namely 38 maunds per acre, is obtained in the Gorakhpur Division, where abundance of natural moisture in the ground and richness of a heavy, deep loam specially favour the luxuriant growth of sugarcane. Moreover, the high outturn may be justified by the superior quality of the races of cane, *viz.*, *Reorá*, *Hemjá*, *Pansáhi*, and *Mango* commonly grown in that division.

The next best outturn (36 maunds per acre) is got in the Meerut Division. This may be attributed to the deep tillage usually resorted to in the division, the facilities of canal irrigation, and a generally advanced system of agriculture, as well as to the superior quality of the canes grown in the division, especially the *dhaur* cane, which is famous for its high outturn, and to the efficiency of the iron mills commonly used. The Benares Division comes next, with an average outturn of 35 maunds per acre. Here the cultivator is very industrious, the soil and climate remarkably suitable, and the races of cane cultivated, especially the *Reorá* and the *Pansári*, are most admirable. Besides, the *Beha* three-roller mill is largely used in Ballia and Gházipur, and it extracts a very high percentage of juice.

The fertile soil of the Rohilkhand Division is specially suitable for cane cultivation on account of much natural moisture in it, the crop in places being grown even without irrigation: for example, in the *khádar* lands of Bijnor and in parts of Sháhjahánpur. This division produces the average outturn of 34 maunds per acre.

The Allahabad Division includes the districts of Bundelkhand, where the soil is too heavy and the means of irrigation too limited for successful cultivation of sugarcane, the races of cane grown being also poor; and these circumstances bring down the average to 28 maunds per acre.

In Oudh the general average is 30 maunds. The soil is rich enough, the climate quite suitable, the cultivator works hard, but the cattle are generally weak in the cane-growing parts of the Provinces: the tillage is therefore defective and the sources of irrigation are limited. There is no reason why, with improved tillage and better means of irrigation, Oudh should not produce more sugar than it does.

The outturn of the Agra Division is as low as 22 maunds per acre. This is in all probability due to the sandy nature of the soil and the poor kinds of cane commonly grown in that division.

The only district of the Kumaun Division in which cane is grown is Naini Tal. Here the soil is unsuitable and the tillage imperfect. But our experiments and observations in this district have been too few to justify our drawing any definite conclusions about its sugar-producing capacity.

The average outturn of *gur* per acre for the whole province calculated in the above manner comes to 33 maunds per acre. The total produce of *gur* in the United Provinces in a year amounts to over four crores and two lakhs of maunds. Knocking off the fraction to make an allowance for the cane that is chewed, the total yield of the country may be put down roughly at four crores of maunds of *gur*, worth between 10 and 12 crores of rupees.

CONSUMPTION OF RAW AND REFINED SUGARS.

It is very difficult to calculate with any pretensions to strict accuracy the quantity of raw sugar that is consumed annually in its natural state in these

Provinces and the quantity that is refined, as no reliable data on which such calculations could be based are available. But from the knowledge we have acquired of the details and general features of the sugar industry in the various sugar-producing tracts of the country in the course of our enquiries, we think we cannot be far wrong in assuming that one-sixth of the total outturn of raw sugars calculated in terms of *gur* is refined in the Meerut Division, one-half in Rohilkhand, one-third in Benares, one-half in Gorakhpur, one-sixth in Fyzabad, and one-twelfth in the Lucknow, Allahabad, and Agra Divisions. The outturn of the Kumaun Division, which is not a sugar-refining tract, may be treated as all eaten raw. The subjoined table based on the above assumption shows the estimated quantity of *gur* refined in each division:—

| Name of division. | | | | | Total outturn of <i>gur</i> in the division. | Fractional part refined. | Quantity of <i>gur</i> refined in the division. |
|-------------------|-----|-----|-----|-----|--|-----------------------------|---|
| | | | | | Mds. | | Mds. |
| Meerut | ... | ... | ... | ... | 88,86,802 | $\frac{1}{6}$ | 14,81,133 |
| Agra | ... | ... | ... | ... | 12,24,873 | $\frac{1}{12}$ | 1,02,073 |
| Rohilkhand | ... | ... | ... | ... | 88,96,366 | $\frac{1}{2}$ | 44,48,183 |
| Allahabad | ... | ... | ... | ... | 9,20,098 | $\frac{1}{12}$ | 76,674 |
| Gorakhpur | ... | ... | ... | ... | 72,86,042 | $\frac{1}{2}$ | 36,43,021 |
| Lucknow | ... | ... | ... | ... | 35,87,557 | $\frac{1}{12}$ | 2,98,963 |
| Fyzabad | ... | ... | ... | ... | 38,31,457 | $\frac{1}{6}$ | 6,38,576 |
| Benares | ... | ... | ... | ... | 54,73,048 | $\frac{1}{3}$ | 18,24,349 |
| Kumaun | ... | ... | ... | ... | 1,02,396 | ... | ... |
| Total | | | | | 4,02,08,639 | ... | 1,25,12,972 |

The quantity that undergoes the process of refining is thus roughly about five-sixteenths, or a little over one-fourth of the total outturn of *gur* actually available in the whole Province, which has already been assumed to be four crores of maunds in round numbers. Deducting from it the quantity refined *plus* 36,63,922 maunds, which is the average of the annual net exports for the past 12 years (1886 to 1898), according to the statistical records of the Agricultural Department, the net quantity of *gur* consumed in the raw state comes to 2,38,23,106 maunds. Dividing the latter figure by 4,69,05,085, the population of these Provinces

according to the census of 1891, the consumption of *gur* amounts to about 20 seers per head of population per annum.

Similarly, the consumption of refined sugars per head may be calculated at about three seers per head per annum, assuming three maunds of *gur* as equivalent to one maund of refined sugar, and making allowance for the net export of refined sugar, which, on the average of the past 12 years, amounts to 3,48,188 maunds.
